

FM 55-15

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FM 55-15

DEPARTMENT OF THE ARMY FIELD MANUAL

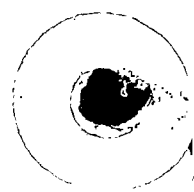
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FIELD MANUAL

No. 55-15

**HEADQUARTERS
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WASHINGTON, D.C., 23 February 1968**

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CHAPTER 1

GENERAL

★1-1. Purpose and Scope

a. This manual is both a planning guide for staff and unit officers and a digest of operational data for use as a reference by operators and users of transportation.

b. This manual includes characteristics of typical transportation equipment and facilities and methods for estimating the capabilities of, or requirements for, transportation equipment, facilities, and troop units. Personnel and equipment data for the modes of transportation and for transportation terminals are presented as well as data for computing requirements for staff, supervisory, and control activities. Factors concerning administrative support requirements are included. It also contains report formats and examples of orders and standing operating procedures. Loading data for water, rail, motor, and air movements; tables on weights, measures, and conversion factors; and miscellaneous data of gen-

eral usefulness are included. Planning data contained herein may be modified as necessary to meet known conditions and requirements.

1-2. Application

The material presented herein is applicable to nuclear and nonnuclear warfare.

★1-3. Changes and Revision

Users of this publication are encouraged to submit recommended changes and comments to improve the publication. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the Commandant, US Army Transportation School, ATTN: ATSTC-D, Fort Eustis, Va. 23604.

CHAPTER 2

AIR

★Section I. ARMY AVIATION IN THE TRANSPORT ROLE

2-1. General

The evolution of warfare has generated a need for greater mobility in support of the Army. Army aviation is an integral part of the transportation system designed to provide efficient and effective movement of personnel and cargo. Army aviation units provide airlift in support of requirements of the theater army, field army, corps and division. In addition, Army aviation units are capable of providing airlift in support of a unified or specified command, a military assistance advisory group or mission operating detachment, or a separate brigade operation. Because of the high mobility requirements of today's Army, considerable reliance is placed on the air mode of transportation provided by Army aviation units. These units are separated into two categories, divisional and nondivisional.

a. Divisional. Aviation elements which are organic to a division are authorized on the basis of each type division's requirement for constantly available aviation support. An airmobile division, which has a constant requirement for large numbers of aircraft, is authorized an aviation group. Each infantry and airborne division is authorized an aviation battalion, and armored and mechanized divisions are each authorized one aviation company. Each armored infantry, mechanized, and airborne division is also authorized an air cavalry troop organic to the armored cavalry squadron. The airmobile division is authorized three air cavalry troops organic to the air cavalry squadron.

b. Nondivisional. To meet the varying requirements of subordinate divisions for aviation support, and to augment the organic aviation assets of other field army elements, separate aviation organizations are included in the

army field force structure. These separate aviation units are referred to as nondivisional aviation units. They normally include helicopter elements which are capable of performing airlift missions and of providing direct aerial fire support to subordinate divisions. Special purpose aircraft, such as medium lift helicopters and reconnaissance and surveillance airplanes are also included. These aircraft are normally assigned to a field army with further attachment to subordinate corps.

2-2. Organization

The table of organization and equipment (TOE) of each military unit prescribes its normal mission, organizational structure, and personnel and equipment authorization. Users who need detailed information on any specific aviation unit should use the TOE of that unit (see table 2-1) and FM 1-15.

2-3. Mission

The mission of Army aviation units is to provide airlift of personnel and cargo for combat service support and combat support operations as required. Missions assigned to an aviation unit are usually similar to the normal mission as stated in the TOE.

a. Objective. Missions are assigned to the aviation company with the objective of assisting in the accomplishment of the mission of the land force.

b. Authority. When the aviation company is placed in support of a ground unit, the ground unit commander assigns tasks to the aviation commander for execution. The aviation commander retains authority to issue orders to elements under his command as necessary to accomplish these tasks.

Table 2-1. TOE Organizations

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>
*Light Airmobile Company ----- Airborne Division.	1-57G	To provide tactical air movement of troops and equipment in airmobile operations.	Aviation Battalion Airborne Division TOE 1-55.
*Assault Helicopter Company -----	7-77	To provide tactical air movement of troops and equipment in airmobile operations.	Combat Aviation Battalion Inf-Div TOE 7-75.
Assault Support Helicopter Company -----	1-258H	To provide air transport of personnel and cargo for combat service support and combat support operations.	To a field army, theater army support command, or other commands as required. Normally, attached to an Aviation Battalion, TOE 1-256.
Assault Helicopter Company ----- Separate.	7-357H	To provide tactical air movement of troops, supplies and equipment within the combat zone.	To a field army or other commands as required. Normally, attached to a Combat Aviation Battalion, TOE 1-256.
Heavy Helicopter Company ----	55-259H	To provide combat service support airlift for movement of heavy supplies, vehicles, aircraft and equipment, and as directed, to provide combat support airlift of combat units and air supply of units engaged in combat operations.	To a Combat Aviation Group, TOE 1-252. Normally, attached to an Aviation Battalion, TOE 1-256.

Note. An asterisk indicates those TOE units without organic DS maintenance capability. This capability is provided by the attachment of appropriate DS element as necessary or mission essential.

★Section II. COMBAT SERVICE SUPPORT

2-4. Airlift of Materiel

The airlift of materiel within the combat zone (CZ) is accomplished through employment of Army aviation and Air Force tactical airlift elements. Best utilization is attained by adapting to the situation the most appropriate airlift capabilities of each service to provide an air line of communications.

a. Intertheater airlift is an Air Force function. Air Force aircraft are used also for the airlift of materiel from rear areas, as from the communications zone (COMMZ) or field army area, to points as far forward as practicable. These airlifts use the throughput concept, under which shipments bypass one or more intermediate supply points.

b. Material delivered to overseas supply points on a wholesale basis by Air Force airlift or by surface modes can be further moved by Army helicopters to using units, or to supply points established for using units. The aerial resupply of land combat forces operating in

forward areas is accomplished primarily by Army aviation units, but Air Force elements may participate also in this function. In that situation, it may be necessary to attach the Air Force airlift elements to the land force.

2-5. Employment Considerations

Although optimum utilization of airlift would be attained by use of Air Force transport aircraft to move materiel from a COMMZ depot directly to the user, this is often impracticable in a tactical situation. There normally must be a point at which wholesale airlift is terminated and retail deliveries to the user are undertaken by Army aviation elements. Factors to be considered in determining the point at which wholesale airlift is terminated include the following:

a. *Airfields.* Suitable airfields must be available at points into which materiel is to be airlanded by Air Force transport aircraft.

b. *Enemy Action.* The enemy may be cap-

able of limiting or denying the use of forward areas for airlanding by transport aircraft.

c. Receiving Unit Capability. Combat units in forward areas have a limited capability to receive, store, protect, and redistribute materiel airlanded in wholesale lots by transport aircraft.

d. User Requirements. The user may be a unit of company size or smaller that requires resupply in retail quantities only.

2-6. Principles of Employment

The efficient employment of Army aviation is based upon the following considerations:

a. Economy of Utilization. Aircraft should not be used when surface means are equally effective. Since there are seldom enough aviation assets to satisfy all requirements of commanders, most aviation support is allocated on a priority basis.

b. Ready Availability. The ability to respond rapidly to demands for aviation support increases the value of this mode of transportation to supported commanders. Ready availability is obtained by locating aviation units as close as practicable to the supported units. Also the inherent mobility of aircraft permits support to be made available to units that are located throughout a wide area. Ready availability is also attained by intelligent scheduling of operational aircraft and by programing of required maintenance.

2-7. Operational Considerations

a. Air Density. Unlike surface modes of transportation, where the payload of a particular vehicle is relatively fixed, aircraft payloads are affected by air density. Denser air provides greater lift to an aircraft's wing or rotor blade, thus increasing the weight-lifting performance of the aircraft. Air density is affected by temperature, altitude, and humidity.

(1) *Temperature.* An increase in temperature causes a decrease in air density. The amount of air that occupies 1 cubic inch at low temperature will expand and occupy 2 or 3 cubic inches as the temperature rises. It is important to recognize that the payload of a par-

ticular aircraft can change, depending on the time of day when a flight is scheduled. Usually early morning temperatures favor operations and noonday heat causes a decrease in the efficiency of the aircraft.

(2) *Altitude.* An increase in altitude causes a decrease in air density. This factor is particularly important in operations conducted from areas high above sea level. It is necessary either to decrease the aircraft weight or to increase the length of takeoff and landing strip.

(3) *Humidity.* An increase in humidity causes a decrease in air density. Air always contains some moisture in the form of water vapor, but the amount varies from almost none to 100 percent. This water vapor is known as humidity. As humidity increases, water particles displace the air, causing a decrease in air density and reducing the performance efficiency of an aircraft.

b. Distance. The distance to be flown is particularly important in utilization of Army aviation transport because the allowable load is computed after the amount of fuel, plus reserve, is determined. Aircraft must carry less fuel with a relative reduction in distance flown when maximum payload is desired, and payload must be reduced when maximum distance is the important factor.

c. Weather. Weather conditions influence the operations of Army aviation elements. While low ceilings and limited visibility may restrict operations, such conditions may be used as an advantage in shielding the aircraft from enemy observation. However, adverse weather generally reduces the efficiency of Army air transport operations. Although Army transport aircraft can operate under instrument flight conditions, commanders should establish weather minimums to preclude scheduling flights that jeopardize the safety of aircraft and personnel. Weather minimums should be established commensurate with the experience of the pilots, type of aircraft employed, urgency of mission, navigational aids available, terrain along the flight route, and time of operation.

d. Enemy Situation. The location and capabilities of enemy forces should be considered before flight routes for Army air transport op-

erations are finalized. Every effort should be made to avoid areas where suspected enemy anti-aircraft weapons or known enemy ground fire exist. Aviation units should have prearranged evasive-action flight plans in the event enemy aircraft are encountered.

e. Terrain. Terrain features must be considered with regard to their possible effects on each operation. Terrain influences the following:

- (1) Location of takeoff and landing sites.
- (2) Flight routes.
- (3) Identification of prominent landmarks for navigational purposes.
- (4) Location of navigational aids.
- (5) Location of emergency landing sites.

f. Flight Routes. Many demands for the use of airspace are generated during combat operations. The employment of aircraft of the Army and other services, artillery, drones, and missiles must be coordinated to insure adequate safety, proper identification, and efficiency of operations. Army aviation units are responsible for making sure that flight routes are properly coordinated and approved by the appropriate air traffic control facility before combat service support or combat support operations are begun.

g. Communications. Combat service support and combat support airlift operations require that adequate communications be established before the beginning of a mission. Voice communication is necessary among the following: Army airlift and command units, supported organizations, inflight aircraft, and takeoff and landing sites.

2-8. Support Requirements

Primary support requirements influencing the employment of Army aviation are the availability of petroleum, oils and lubricants (POL), ammunition, and aircraft maintenance support.

a. POL. Aircraft consume large quantities of fuel. POL items require special handling. Refueling facilities should be readily available.

b. Ammunition. The ammunition used in Army aircraft may be expended rapidly. This necessitates locating resupply facilities near the

area of operations to avoid the time penalty involved in lengthy flights to obtain supplies.

c. Aircraft Maintenance. The capability of aviation units in the performance of aircraft operations on a sustained basis is dependent upon efficient aircraft maintenance. Maintenance of aircraft begins with that performed by unit personnel and extends through direct support (DS) and general support (GS) to depot maintenance. To assure continuing availability of aircraft, close coordination is required between the aviation unit commander, the ground combat commander, and the supporting maintenance unit commander. Proper scheduling of aircraft is mandatory to prevent maintenance overload which can result in excessive down time for aircraft. For any large operation, personnel and aircraft from maintenance support units should be allocated for aircraft recovery and repair. Normally, airlift planners are concerned with aircraft maintenance support through the DS level categorized as follows:

(1) *Organizational.* Organizational aircraft maintenance is performed by personnel of the aviation unit. This maintenance includes the inspection, servicing, lubrication, and adjustment of aircraft components as well as the replacement of parts and minor assemblies within unit capability as prescribed by the maintenance allocation chart (MAC).

(2) *Direct support.* Aviation units possessing an integrated DS capability can perform this maintenance for their own aircraft. Those organizations listed in table 2-1 have this capability; units not having it are dependent upon support elements for DS services. The major function of DS maintenance is the repair of end items or unserviceable assemblies for return to the using unit. Direct support elements also can install in aircraft certain components which an aviation unit's own personnel cannot install.

(3) *Aircraft maintenance support elements.* Aircraft maintenance support exceeding capabilities organic to the aviation unit is provided as follows:

(a) Divisional aircraft receive DS maintenance to include avionics and armament sup-

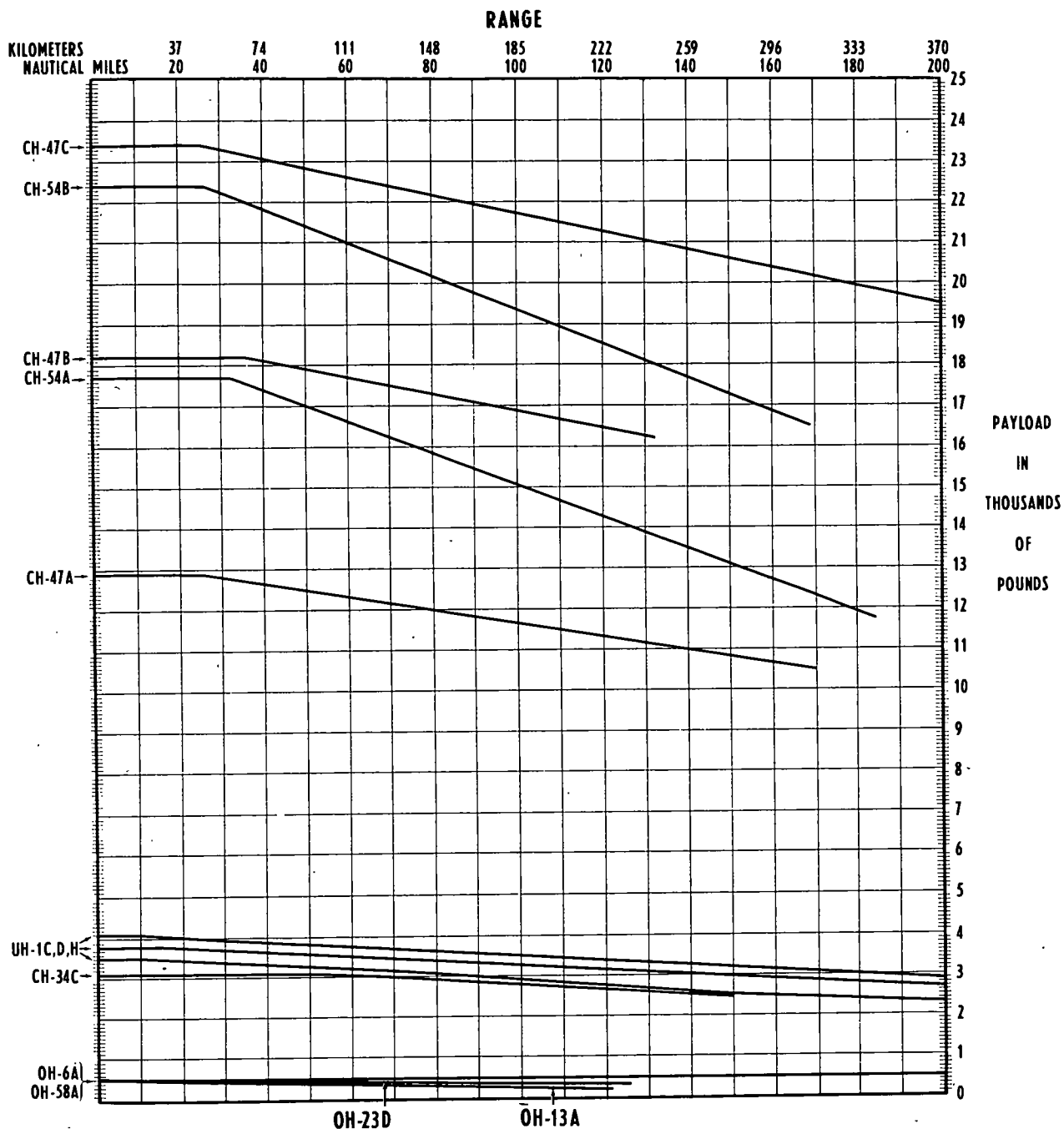


Figure 2-1①. Payload versus range of Army helicopters.

port from their organic transportation aircraft maintenance company, within the maintenance battalion of the division support command (DISCOM). In the airmobile division, the DIS-

COM transportation aircraft maintenance and supply battalion provides aircraft DS maintenance including avionics and armament maintenance and repair parts support.

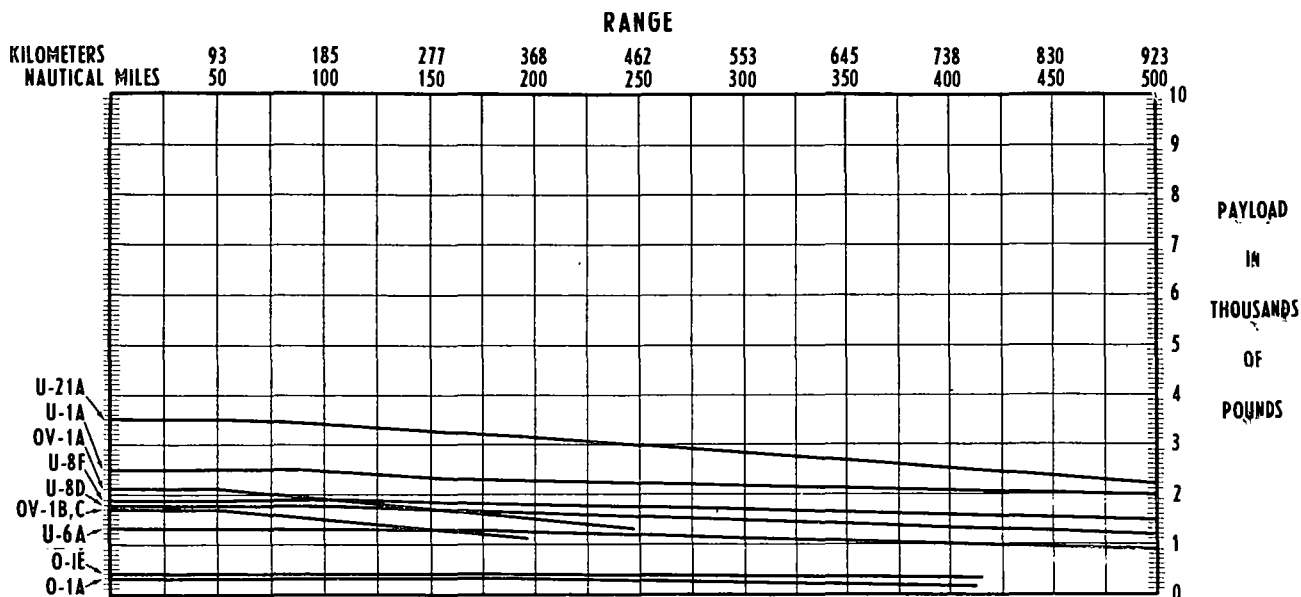


Figure 2-1②. Payload versus range of Army airplanes.

(b) Nondivisional aircraft in the corps areas receive DS maintenance from the transportation aircraft direct support company located in the corps support brigade of the field army support command (FASCOM).

(c) Aviation units in the Army rear area receive DS maintenance from the transportation aircraft direct support companies located in the army rear support brigade.

2-9. Army Aircraft Payload Versus Range

a. *General.* Payload is the number of passengers and/or the amount of cargo that an aircraft can carry, usually expressed in pounds. As the distance to be flown is increased, the fuel required is increased and the payload is decreased. The payload varies with changes in altitude, temperature, air pressure, humidity, and wind.

b. *Computations for Range versus Payload.* Payload for various ranges may be approximated for Army aircraft by using figures 2-1① and 2-1②. The data in these figures have been taken from the appropriate TM 55-series

-10 aircraft operator's manual. The range includes a fuel reserve of one-half hour. Figures 2-1① and 2-1② are rapid references that should be used for general planning only. When cargo operations are to be planned over distances greater than 200 nautical miles, see the TM -10 series for detailed information.

2-10. Aircraft Characteristics

a. *Army Aircraft Characteristics.* Characteristics of Army aircraft are shown at tables 2-2 and 2-3. Figures 2-4 through 2-18 illustrate selected Army aircraft. Figure 2-19 illustrates the detachable universal pod for the CH-54.

b. *Air Force Transport Aircraft Characteristics.* Characteristics of Air Force transport aircraft are shown at table 2-4 and figure 2-3.

c. *Cargo Compartment Envelopes.* Figure 2-2 illustrates the cargo compartment envelopes and access limitations of Air Force aircraft and selected Army helicopters.

Table 2-2. Army aircraft characteristics (helicopters)

(Located in back of manual.)

Table 2-2. Army aircraft characteristics (helicopters)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A. HELICOPTER	UNIT	OH-6A OBSERVATION	OH-13H OBSERVATION	OH-58A (ARMED) OBSERVATION	UH-1H ¹ UTILITY	UH-1C ¹ /M ¹ UTILITY	UH-1D ¹ UTILITY	UH-1H ¹ UTILITY	AH-1G ATTACK	CH-54C CARGO	CH-47A CARGO	CH-47B CARGO	CH-47C CARGO	CH-54A CARGO	CH-54B CARGO
B. NAME		CAYUSE	SILOX	KIOWA	IROQUOIS	IROQUOIS	IROQUOIS	IROQUOIS	COBRA	CHOCOTAW	CHENOOK	CHINOOK	CHENOOK	TARHE	TARHE
C. CREW (200 Lbs Ea)	Ea	2	1	2	1	1	1 ²	1 ²	2	2	3	3	3	3	3
D. DIMENSIONS:															
(1) Length - Fuselage	Ft & In	23' 6"	31' 4 3/4"	32' 3 1/2"	42' 8 1/2"	42' 8"	41' 11 1/4"	41' 11 1/4"	44' 5 1/5"	46' 9"	51' 0"	51' 0"	51' 0"	70' 3"	70' 3"
(2) Length - Blades Unfolded	Ft & In	30' 3 3/4"	41' 4 3/4"	40' 11 3/4"	53' 0"	53' 0"	57' 1"	57' 1"	52' 11 3/6"	65' 10"	98' 3 1/6"	98' 11"	99' 0"	88' 5"	88' 5"
(3) Length - Blades Folded	Ft & In	23' 0"	NA	32' 3 1/2"	NA	NA	NA	NA	NA	37' 0"	51' 0"	51' 0"	51' 0"	77' 6"	77' 6"
(4) Width - Blades Folded	Ft & In	NA	NA	NA	NA	NA	NA	NA	NA	13' 0"	12' 5"	12' 5"	12' 5"	21' 10"	21' 10"
(5) Width - Tread	Ft & In	6' 9 1/4"	7' 6"	6' 3 1/2"	8' 4 3/4"	8' 4 1/2"	8' 6 1/2"	8' 6 1/2"	7' 4"	12' 0"	11' 11"	10' 6"	10' 6"	19' 9"	19' 9"
(6) Height Extreme	Ft & In	8' 6"	9' 5 1/2"	9' 6 1/2"	14' 8 1/2"	14' 9"	14' 5 1/2"	14' 5 1/2"	11' 7"	15' 11"	18' 6 1/2"	18' 7"	18' 7"	25' 5"	25' 5"
(7) Diameter Main Rotor	Ft & In	26' 4"	35' 1 1/2"	35' 4"	44' 0"	44' 0"	48' 0"	48' 0"	44' 0"	56' 0"	59' 1 1/4"	60' 0"	60' 0"	72' 0"	72' 2"
(8) Diameter Tail Rotor	Ft & In	4' 3"	5' 10 1/4"	4' 4"	8' 6"	8' 6"	8' 6"	8' 6"	8' 6"	9' 6"	51' 2"	52' 0"	52' 0"	16' 0"	16' 0"
E. CARGO DOOR ³															
(1) Dimensions - Width/Height	In	NA	NA	NA	48/48	48/48	74 5/48	74 5/48	NA	53/48	90/78	90/78	90/78	Pod - 114/92	Pod - 114/92
(2) Location - Side of Fuselage	In	NA	NA	NA	Both	Both	Both	Both	NA	Right	Rear	Rear	Rear	Pod - Rear	Pod - Rear
F. CARGO COMPARTMENT ³															
(1) Height of Floor Above Ground	In	NA	NA	NA	27	27	32	32	NA	34	30	30	30	Pod - 18	Pod - 18
(2) Length Usable	In	NA	NA	NA	48	48	92	92	NA	161	362 1/2	362 1/2	362 1/2	Pod - 329	Pod - 329
(3) Width Floor	In	NA	NA	NA	80 1/2	80 1/2	96	96	NA	60	90	90	90	Pod - 104	Pod - 104
(4) Height (Clear of Obstructions)	In	NA	NA	NA	48	48	49	49	NA	70	78	78	78	Pod - 78	Pod - 78
(5) Cargo Space Optimum	Cu Ft	NA	NA	NA	140	140	220	220	NA	405	1,487	1,487	1,487	Pod - 1,599	Pod - 1,599
G. EXTERNAL CARGO ⁴															
(1) Maximum recommended external load	Lbs	NA	NA	NA	3,675	4,000	4,000	4,000	NA	4,000	14,916	20,000	20,000	20,000	25,000
(2) Rescue Hoist Capacity	Lbs	NA	NA	NA	600	600	600	600	NA	600	600	600	600	NA	NA
(3) Winch Capacity	Lbs	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,000	3,000	3,000	15,000	25,000
H. PASSENGER CAPACITY ³															
(1) Troop Seats (240 Lbs Per Man)	Ea	2	2	2	6	6	11	11	0	18	33	33	33	Pod - 45	Pod - 45
(2) Litters	Ea	0	2	0	3	3	6	6	0	8	24	24	24	Pod - 24	Pod - 24
I. OPERATIONAL CHARACTERISTICS ^{4, 5}															
(1) Maximum Allowable Gross Wt	Lbs	2,400	2,450	3,000	8,500	9,500	9,500	9,500	9,500	12,068	33,000	40,000	46,000	42,000	47,000
(2) Basic Weight	Lbs	1,163	1,850	1,700	4,600 ¹	4,830 ¹	4,939 ¹	4,900 ¹	8,404	7,800	18,084	19,194	19,772	20,650	21,000
(3) Useful Load	Lbs	1,237	600	1,300	3,900	4,670	4,561	4,100	1,096	4,268	14,916	20,806	26,228	21,350	26,000
(4) Internal Fuel Capacity	Lbs/Gal	400/61.5	250/41.5	475/73	1,075/165	1,575/242	1,450/224	1,450/224	1,605/247	1,572/262	4,036/621	4,036/621	7,353/1,131	8,800/1,353	8,775/1,350
(5) Normal Cruising Speed ⁶	Kts	100	70	100	90	110	110	110	120	100	110	120	120	95	80
(6) Endurance at Cruising Speed ⁶	Hrs + Min	2 + 30	1 + 30	2 + 10	1 + 30	1 + 55	1 + 50	1 + 55	1 + 50	2 + 20	1 + 30	1 + 00	2 + 00	1 + 50	1 + 40
(7) Grade of Fuel	Oct	JP-4/5	80/87	JP-4	JP-4	JP-4	JP-4	JP-4	JP-4	115/145	JP-4	JP-4	JP-4	JP-4	JP-4
(8) Fuel Consumption Per Hour ⁷	Lbs/Gal	130/20	120/20	180/28	528/81	657/101	618/95	605/93	630/105	630/105	1,480/305	2,620/403	3,000/462	3,614/556	3,990/613

FOOTNOTES:

^{1/} Basic weight for standard aircraft (weapons systems and components not included).^{2/} Crew requirements may vary with mission and/or environment.^{3/} Pod for CH-54A (column 15) and CH-54B (column 16).^{4/} Detail weight computations and characteristics taken from FM 101-20-1 or from appropriate aircraft operator's manuals (TM 55-series-10).^{5/} All data computed at standard conditions at sea level.^{6/} Airspeeds and fuel consumption will vary. Endurance time shown is computed using full fuel minus a 30-minute reserve.^{7/} Computed at maximum gross weight and at sea level.

Table 2-8. Army aircraft characteristics (airplane)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
A. AIRPLANE	UNIT	O-1A OBSERVATION	O-1E OBSERVATION	O-1F OBSERVATION	O-1G OBSERVATION	OV-1A OBSERVATION	OV-1B OBSERVATION	OV-1C OBSERVATION	U-1A UTILITY	U-6A UTILITY	U-80 UTILITY	U-8F UTILITY	U-21A UTILITY
B. NAME		BIRD DOG	BIRD DOG	BIRD DOG	BIRD DOG	MOHAWK	MOHAWK	MOHAWK	OTTER	BEAVER	SEMINOLE	SEMINOLE	UTE
C. CREW (200 Lbs Ea)	Ea	1	1	1	1	2	2	2	1	1	1	1	2
D. DIMENSIONS													
(1) Length - Fuselage	Ft & In	25' 0"	25' 9 1/2"	25' 9 1/2"	25' 9 1/2"	41' 1 1/2"	43' 11 1/2"	41' 1 1/2"	41' 10"	30' 5"	31' 6 1/2"	33' 4"	35' 6"
(2) Width - Tread	Ft & In	7' 6 1/2"	7' 6 1/2"	7' 6 1/2"	7' 6 1/2"	9' 2"	9' 2"	9' 2"	11' 2"	10' 2 1/2"	12' 9"	12' 9"	12' 9"
(3) Height Extreme	Ft & In	9' 2 1/2"	9' 2"	7' 6"	9' 2"	12' 8"	12' 8"	12' 8"	12' 7"	10' 5"	11' 6 1/2"	14' 2"	14' 2 1/2"
(4) Wing Span	Ft & In	36' 0"	36' 0"	36' 0"	36' 0"	42' 0"	48' 0"	48' 0"	58' 0"	48' 0"	45' 3 1/2"	45' 10 1/2"	45' 10 1/2"
E. CARGO 000R													
(1) Dimensions - Width/Height	In	45/33	45/33	45/33	45/33	NA	NA	NA	44.5/45	40/40	26 5/26.75	50.5/26.5	53.5/51.5
(2) Location - Side of Fuselage	In	Right	Right	Right	Right	NA	NA	NA	Left	Both	Right	Left	Left
F. CARGO COMPARTMENT													
(1) Height of Floor Above Ground	In	NA	NA	NA	NA	NA	NA	NA	46 1/2	46	48	48	Approx 54
(2) Length Usable	In	59	59	59	59	NA	NA	NA	44	92	86	110 1/2	150
(3) Width Floor	In	26	26	26	26	NA	NA	NA	51 1/2	48	54	55	55
(4) Height (Clear of Obstructions)	In	29	29	29	29	NA	NA	NA	56 1/2	51	53	55	57
(5) Cargo Space Optimum	Cu Ft	25	25	25	25	NA	NA	NA	70	110	115	128	272
G. EXTERNAL CARGO ²													
Maximum recommended external load	Lbs	500	500	500	500	4,000	4,000	4,000	NA	1,000	NA	NA	NA
H. PASSENGER CAPACITY													
(1) Troop Seats (240 Lbs Per Man)	Ea	1	1	1	1	0	0	0	10	5	5	5	6
(2) Litters	Ea	1	1	1	1	NA	NA	NA	8	5	NA	NA	7
I. OPERATIONAL CHARACTERISTICS ^{1,2}													
(1) Maximum Allowable Gross Wt	Lbs	2,100	2,400	2,195	2,400	15,020	16,643	15,302	8,000	5,100	7,300	7,700	9,650
(2) Basic Weight	Lbs	1,542	1,618	1,707	1,618	9,781	11,217	10,379	4,900	3,310	4,978	5,282	5,500
(3) Useful Load	Lbs	558	782	488	782	5,239	5,426	4,923	3,100	1,790	2,322	2,418	4,100
(4) Internal Fuel Capacity	Lbs/ Gal	252/42	246/41	246/41	246/41	1,901/292 1/2	1,930/297	1,930/297	1,280/213	828/138	1,380/230	1,380/230	2,405/370
(5) Normal Cruising Speed ³	Kts	86	86	86	86	200	200	200	104	105	155	160	164
(6) Endurance at Cruising Speed ³	Hrs + Min	4 + 0	4 + 0	4 + 0	4 + 0	1 + 15	1 + 15	1 + 15	6 + 35	6 + 00	6 + 0	6 + 0	4 + 30
(7) Grade of Fuel	Oct	80/87	80/87	80/87	80/87 or 115/145	JP-4	JP-4	JP-4	115/145	115/145	115/145	115/145	JP-4/5
(8) Fuel Consumption Per Hour ⁴	Lbs/ Gal	54/9	54/9	54/9	54/9	1,105/170	1,105/170	1,105/170	180/30	132/22	204/34	204/34	500/83

FOOTNOTES:

1/ All data computed at standard conditions at sea level.

2/ Detail weight computations and characteristics taken from FM 101-20-1 or from appropriate aircraft operator's manuals (TM 55-series-10).

3/ Airspeeds and fuel consumption will vary. Endurance time shown is computed using full fuel minus a 30-minute reserve, except turboprop which requires a 20-minute reserve.

4/ Computed at maximum gross weight and at sea level.

Table 2-4. US Air Force Transport Aircraft Characteristics

TABLE 2-4. U. S. AIR FORCE TRANSPORT AIRCRAFT CHARACTERISTICS

	C-7A (Caribou)	C-146F (Commando)	C-147D (Sky Train)	C-54G (Sky Master)	C-97C (Strato- freighter)	C-97B (Strato- freighter)	C-118 (DC-6)	C-119D (Packet)	C-121C (Constel- lation)	C-121B (Super Con- stellation)	C-123B (Provider)	C-124A (Globemaster)	C-124C (Globemaster)	C-130A (Hercules)	C-130B (Hercules)	C-135A (Stratolifter)	C-135B (Stratolifter)	C-141A (Starlifter)	C-5A (Galaxy)
Operating wt (lb)	18,475	31,000	18,000	39,000	83,460	92,400	64,500	43,500	80,900	79,900	36,000	113,000	116,000	69,047	76,000	112,700	117,500	140,000	318,500
with 463 L equip	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	71,047	79,400	112,700	117,500	140,000	318,500
Normal max. gr wt (lb) ^a	28,500	45,000	31,000	69,000	150,000	153,000	107,000	68,300	137,500	135,400	55,200	175,000	185,000	124,200	155,000	270,000	274,000	315,000	728,000
Emergency max. gr wt (lb) ^a	28,500	55,000	33,000	73,000	166,000	169,000	112,000	72,700	145,000	145,000	55,200	180,000	194,500	124,200	174,000	270,000	274,000	315,000	764,500
Max. landing wt (lb)	28,500	55,000	33,000	73,000	130,000	130,000	107,000	72,700	122,000	122,000	-----	168,000	168,000	124,200	130,000	200,000	200,000	257,000	635,850
Emergency max. cargo payload (ACL) (lb) ^b	7,500	17,500	11,400	24,000	40,000	40,600	25,400	19,500	33,100	30,100	12,000	62,000	59,000	25,000	49,000	77,300	77,500	64,405	265,000
Normal max. cargo payload (ACL) (lb) ^b	7,500	16,000	7,500	13,000	27,000	35,600	18,700	12,000	27,100	25,100	12,000	50,000	47,000	25,000	37,000	77,300	77,500	64,405	220,000
Emergency max. troop capacity	32	50	27	49	80	80	70	62	78	78	61	171	171	92	92	119	119	129	245
Normal max. troop capacity (over water/over land)	32	32	27	49	56/56	56/56	70/70	62	78/78	78/78	61	160/171	160/171	78	60/78	80/119	80/119	120/154	75
Litter capacity (no attendants)	20	24	24	36	54	54	54	35	44	44	50	127	127	70	70	44	72	72	N/A
Paratroops	26	N/A	27	N/A	N/A	N/A	N/A	42	N/A	N/A	N/A	112	112	64	54	N/A	N/A	123	75
Average cruise speed (knots)	150	148	146	161	210	212	218	154	223	223	138	202	203	280	280	459	459	423	440
Max. range (nautical mi)	975	1,500	1,000	2,000	2,520	2,520	3,080	1,500	2,700	2,740	1,200	3,810	3,620	2,200	3,540	5,445	6,640	4,800	5,500
ACL - max. cargo space limit (10 lb per cu ft), 463 L or pallet	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24,920	24,920	27,600	27,600	46,680	109,200
Center of gravity limits % MAC	26.0-39.0			16.0-32.0	15.5-34.0	15.5-34.0	16.0-33.0	20.0-30.0	19.0-32.0	19.0-32.0	18.0-32.0	18.0-34.0	18.0-34.0	19.0-30.0	24.4-29.2	18.8-35.0	18.8-35.0	24.0-33.4	NVAL
Center of gravity limits ARM	341.41-357.11	309.0-311.0	279.6-283.1	381.0-407.0	513.0-540.0	513.0-540.0	426.0-448.0	318.0-335.0	661.0-684.0	661.0-684.0	324.3-343.9	550.0-588.0	550.0-588.0	519.0-537.0	526.9-535.1	832.0-871.0	832.0-871.0	922.7-947.0	NVAL
Restraint G factors																			
Forward	4.0	8.0	8.0	8.0	8.0	8.0	1.34	4.5	6.0	6.0	4.0 ^c	3.0	3.0	4.0 ^c	4.0 ^c	8.0	8.0	4.0 ^c	3.0
Aft	2.0	1.5	1.5	1.29	1.5	1.5	1.29	1.5	1.5	1.5	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5
Side	1.5	1.5	1.5	1.00	1.5	1.5	1.00	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	1.5	1.5	1.5	1.5
Vertical (up)	2.0	2.0	2.0	2.47	2.5	2.5	2.47	2.25	2.0	2.0	4.5	2.0	2.0	2.0	4.5	2.0	2.0	2.0	2.5
Vertical (down)	--	4.5	4.5	2.47	2.5	2.5	2.47	2.25	4.5	4.5	4.5	2.0	2.0	4.5	4.5	2.0	2.0	2.0	2.5
Cargo doors																			
Dimensions - width/height (in.)	73.5x74.0	95.5x78.6	84.5x70.6	94.8x66.6	103.2x88.0	103.2x88.0	124.0x78.75	110.4x96	106.5x74.5	106.5x74.5	110.0x96.0	136.0x140.0	136.0x140.0	120.0x108.0	120.0x108.0	78.0x116.4	78.0x116.4	123.25x109.2	228.0x162.0
Location - side of fuselage	rear	left	left	left	rear	rear	aft left	rear	aft left	aft left	rear	rd	rd	rear	rear	rd left	rd left	rear	rd
Cargo compartment					left	left	rd left	aft left	rd left	rd left		elevator well	elevator well						rear
Floor level to ground (in.)	45.6	96.0	56.5	108.0	112.0	112.0	106.0	48.0	rd - 135.3	rd - 135.3	33.5	156.0	156.0	39.0/45.0	39.0/44.0	117.0/138.0	117.0/138.0	50.0/57.0	54.0/73.0
Length usable (in.)	345	572.0	360.5	596.4	763.2	763.2	816.0	442.8	984.0	984.0	345.0	876.0	876.0	492.0 ^d	492.0 ^d	860.0	860.0	840.0 ^d	1459 ^d
Width floor (in.)	81	117.5	88.8	103.2	105.6	105.6	104.0	109.2	121.0	121.0	110.0/155.0	135.0	135.0	123.0	123.0	129.0	129.0	123.0	228.0
Height clear (in.)	75	84.0	76.8	93.6	74.0	74.0	93.0	96.0	80.4	80.4	96.0/110.0	139.0	139.0	109.0	109.0	84.0	84.0	109.0	162.0
Ramp incline (degrees)	16	N/A	N/A	N/A	24	24	N/A	12	N/A	N/A	15	17	17	12.5	12.5	N/A	N/A	11	rd 11 rear 6.5
Typical logistical mission																			
Payload/nautical miles	7,000/400	16,000/1,000	7,500/1,000	13,000/1,900	27,000/1,800	35,600/1,800	18,700/2,000	12,000/1,450	26,500/2,000	27,600/2,000	12,000/990	40,500/1,400	42,000/1,500	25,000/1,800	37,000/2,900	61,120/2,300	61,120/2,300	57,462/4,000	220,000/3,050

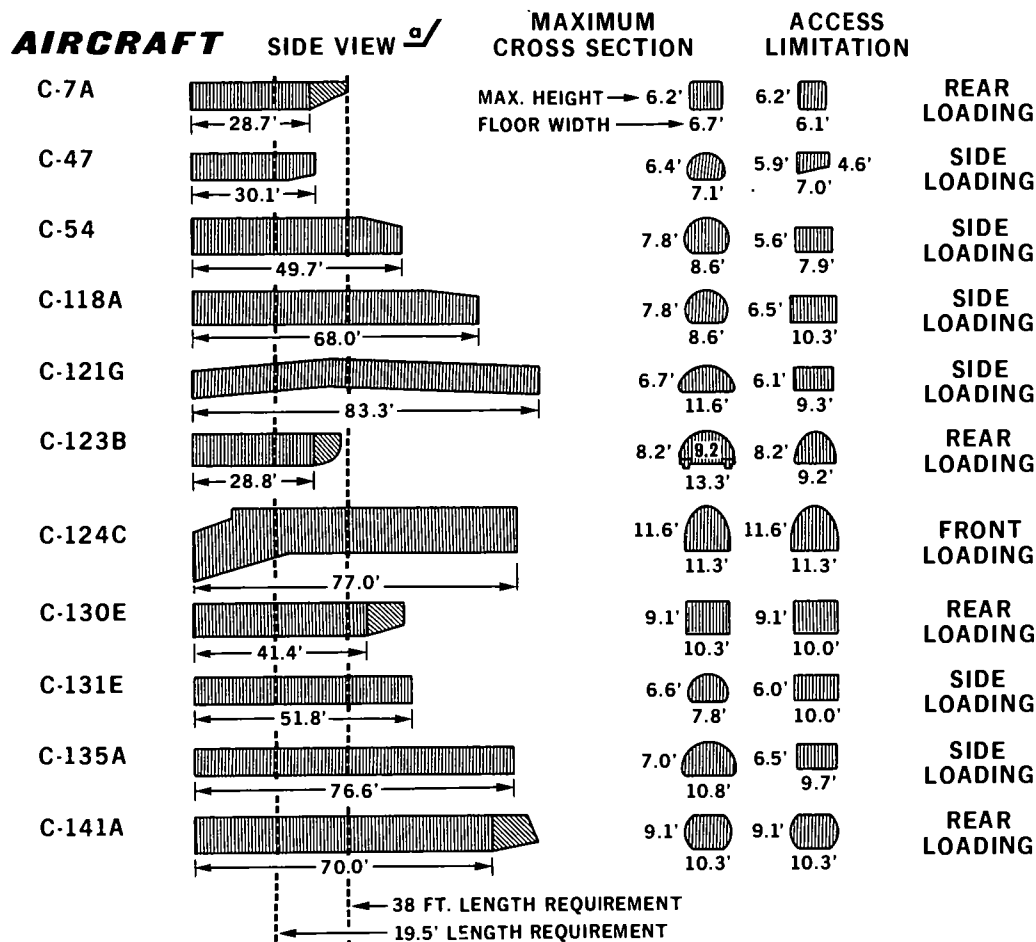
^aMaximum allowable gross weight: The maximum allowed total weight of the aircraft prior to takeoff - the basic weight of the aircraft plus the crew, personnel equipment, special devices, passenger/cargo, and usable fuel and oil. This is limited by structure, power available, or landing load.

^bMaximum allowable cabin loads (ACL) will vary with operating weight of aircraft. Aircraft gross takeoff weight that includes fuel, oil, water, flight personnel, and the logistical range mission determines the maximum allowable payload.

^c8G Restraint factor will be used when passengers are seated forward of cargo.

^dExcludes ramp.

CURRENT CARGO COMPARTMENT ENVELOPE AND ACCESS LIMITATIONS



NOTE: Fig. 2-3 gives C-5A Galaxy cargo compartment and access limitations.

HELICOPTERS

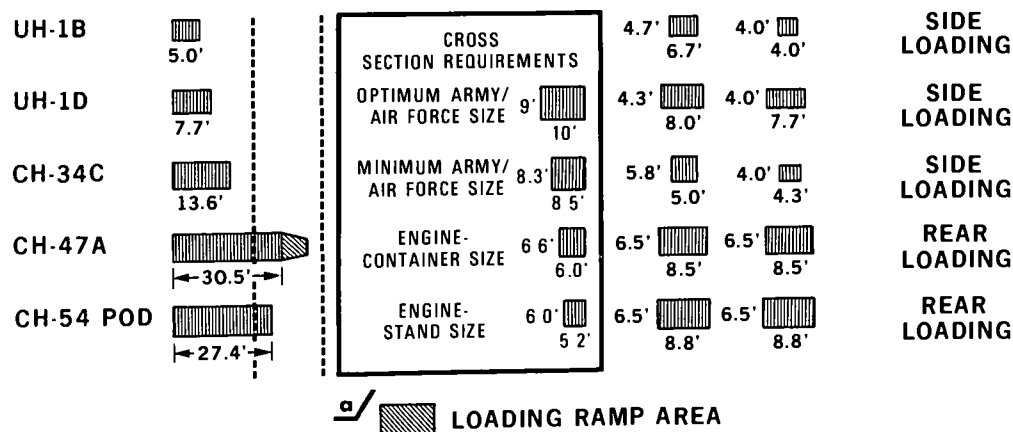


Figure 2-2. Cargo compartment envelope and access limitations.

C-5 INTERIOR

Details of the aircraft interior are shown on this page.

As illustrated, the cargo compartment floor is 121.1 feet long, with a forward ramp 10.1 feet long and an aft ramp 13.4 feet long. The cargo floor and each ramp are 19.0 feet wide, providing 2745 square feet of total floor area. This includes the area shadowed by the deployed troop ladder and crew ladder. Subtracting this area from the total leaves 2702 square feet of usable cargo area. The entire area is air conditioned and fully pressurized.

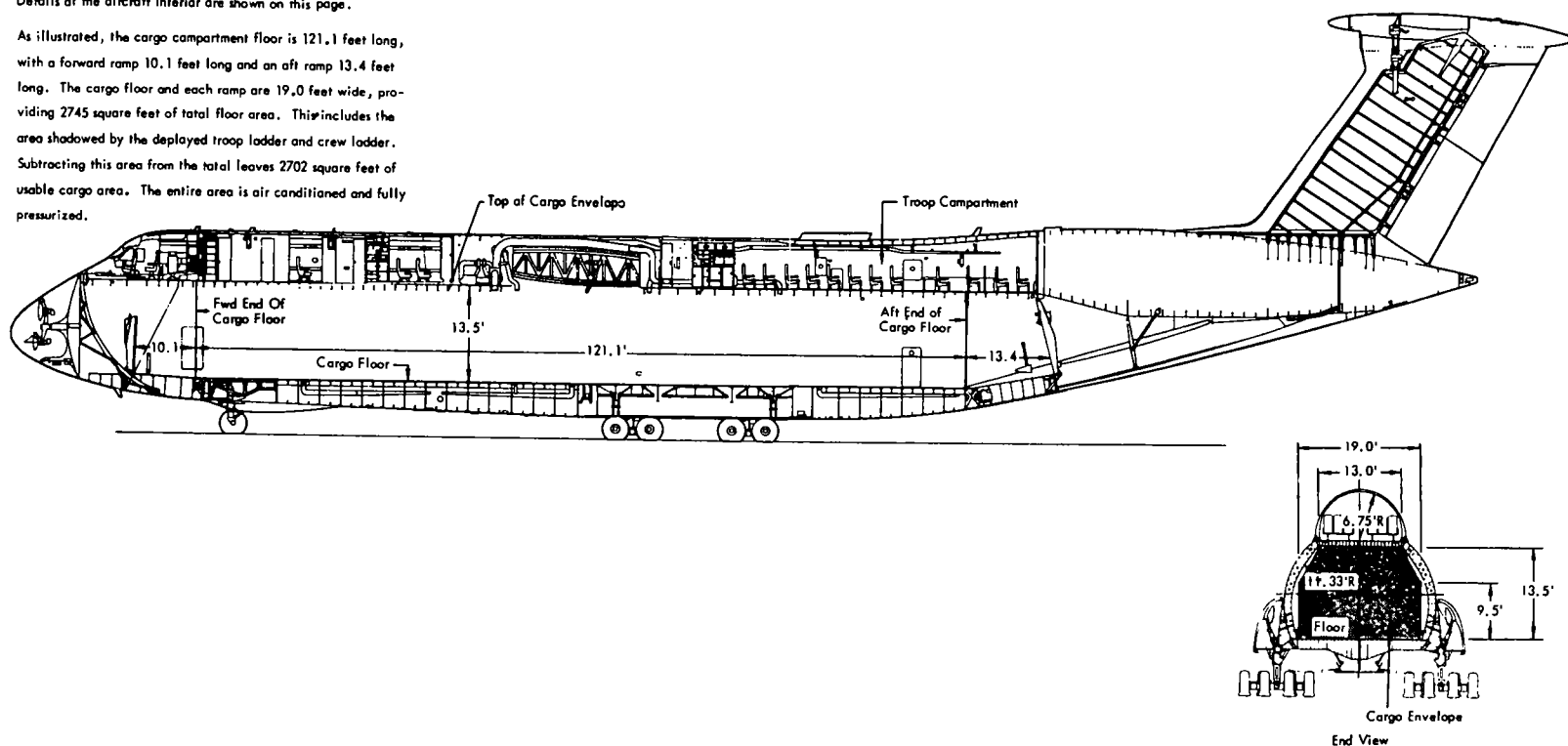


Figure 2-3. C-5A (Galaxy) cargo compartment.

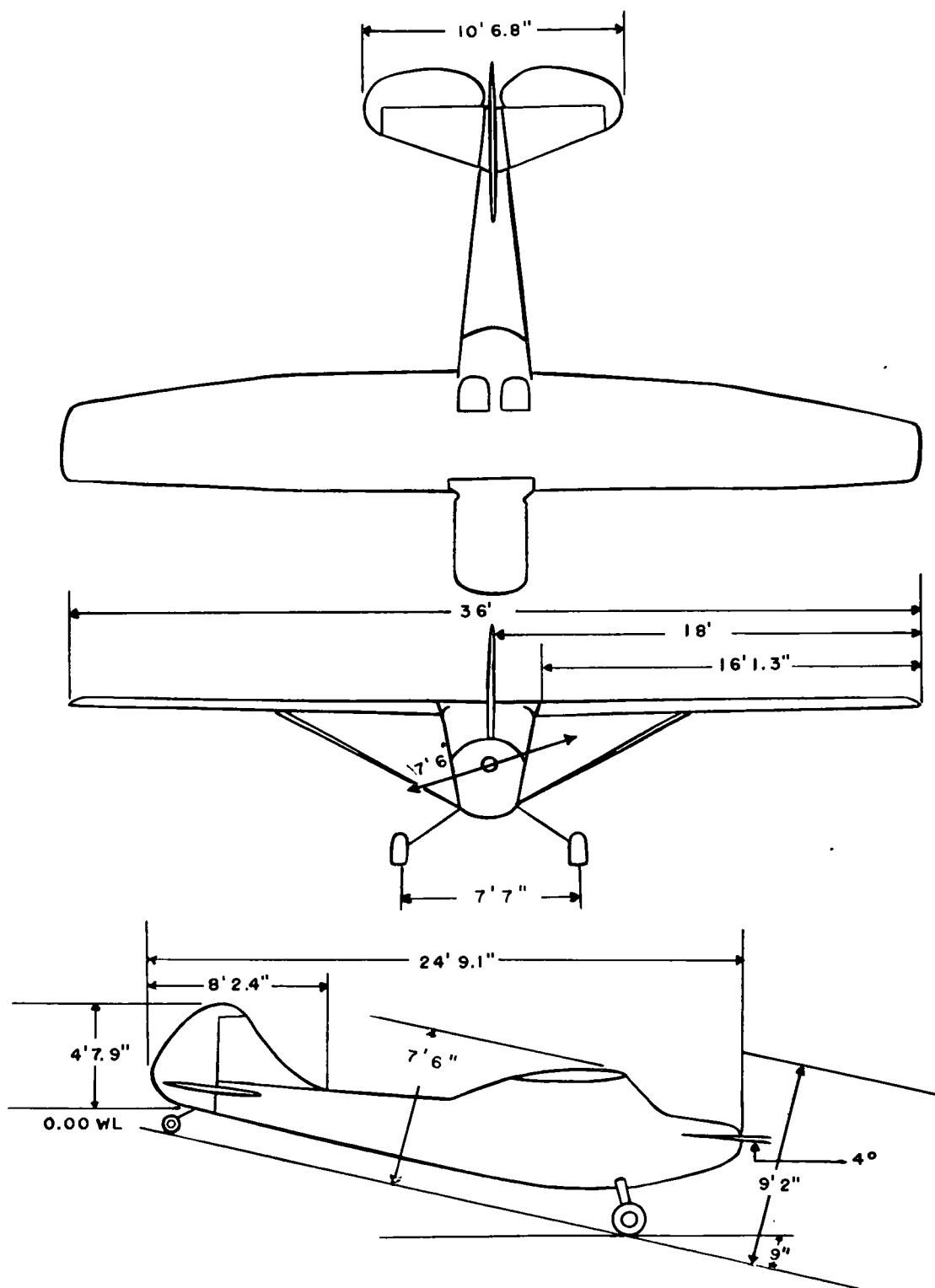


Figure 2-4. O-1E (Bird Dog).

WING
AREA 330 SQ FT
MAC 98 IN.
ASPECT RATIO 5.35
SECTION
NACA 2412
SWEEP AT 40% CHORD 0

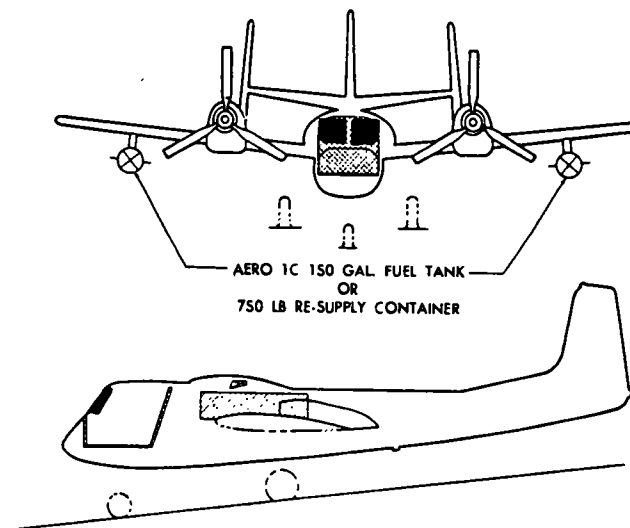
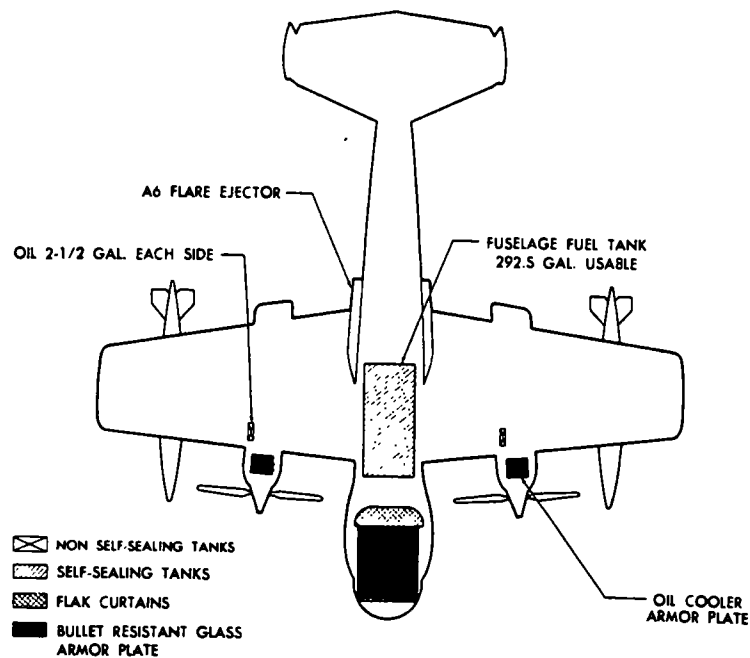
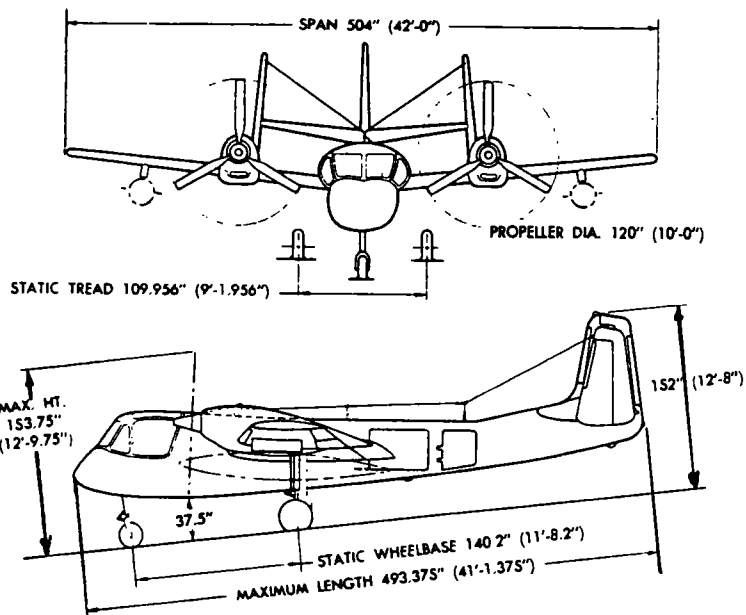
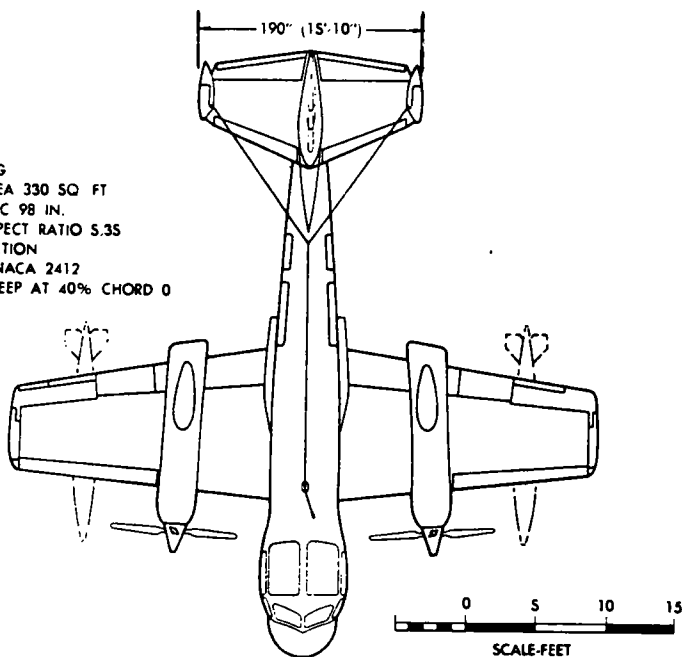


Figure 2-5. OV-1A (Mohawk).

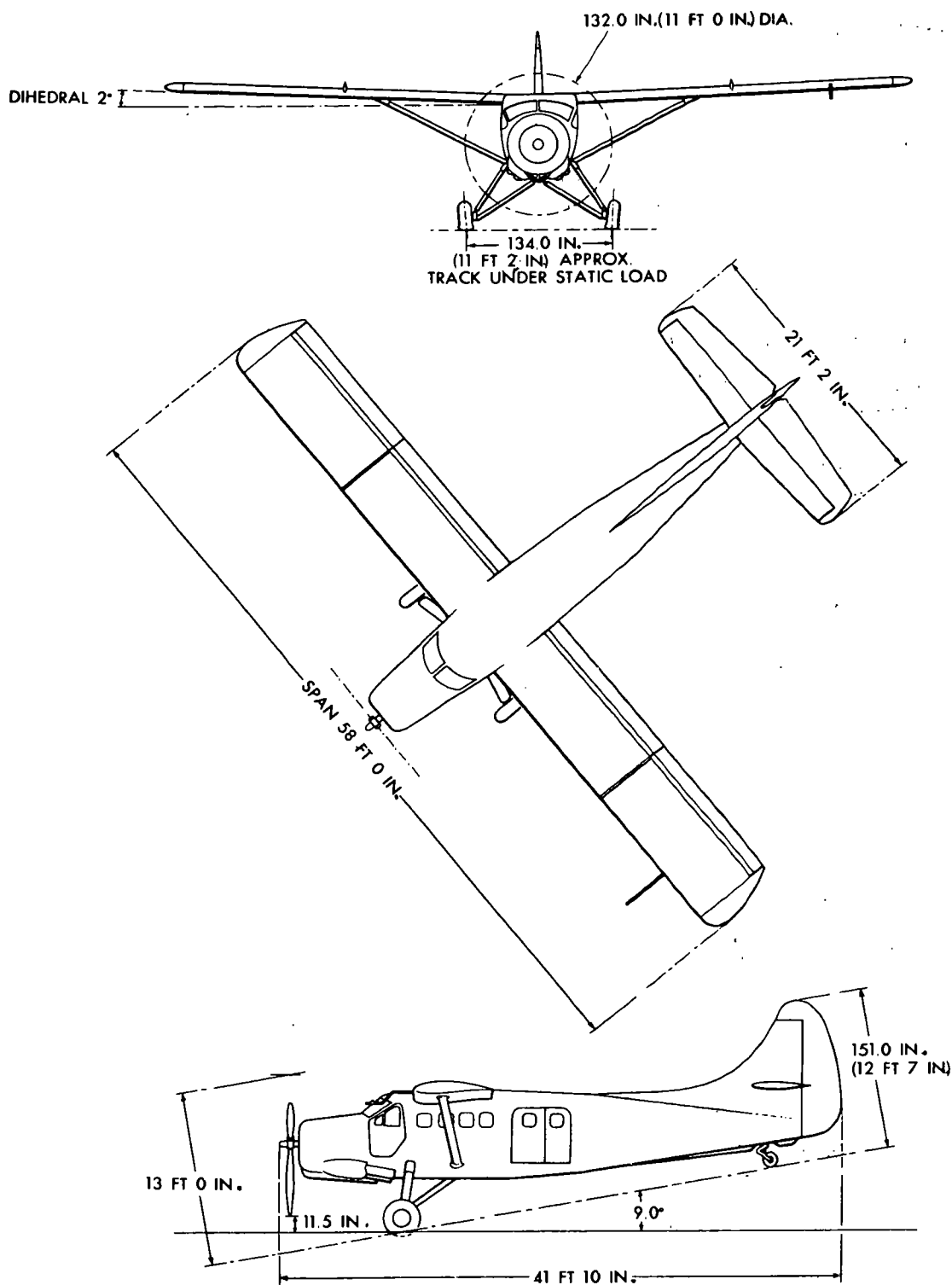
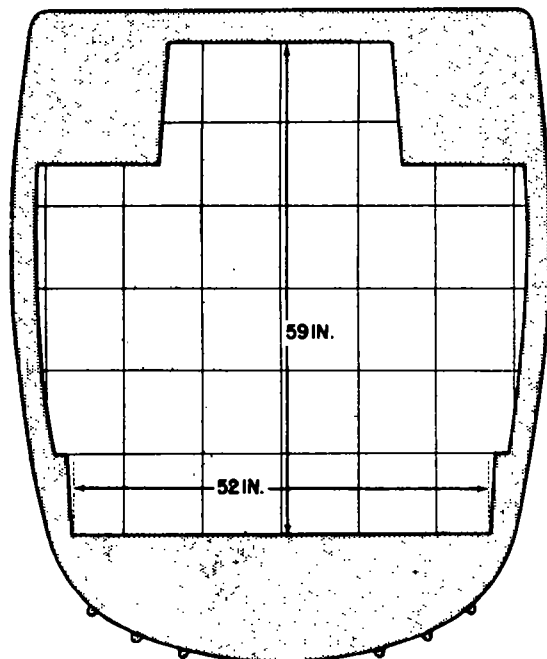
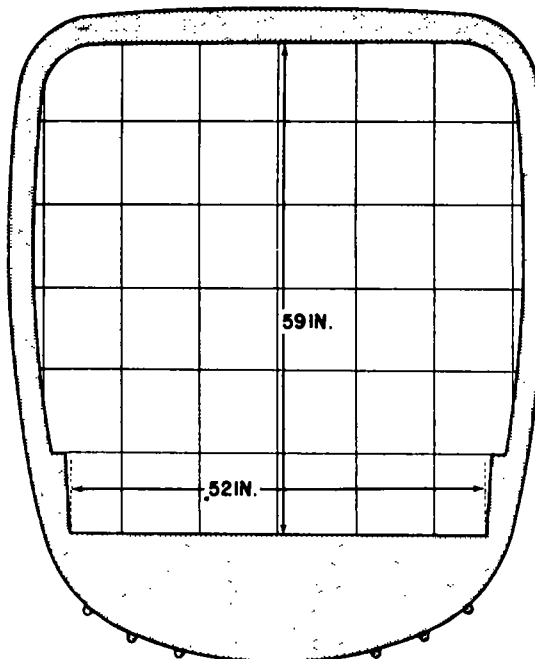


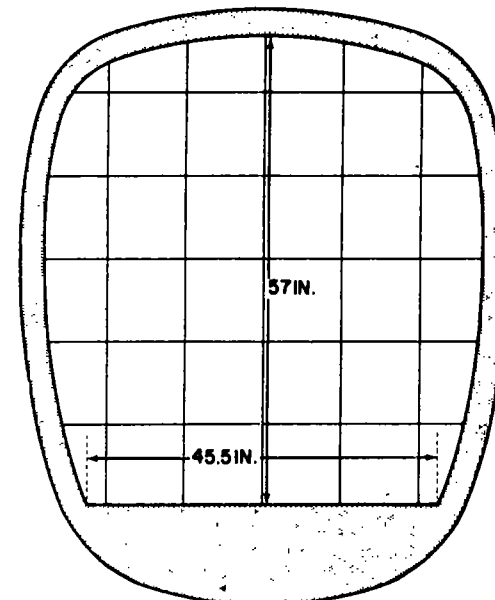
Figure 2-6. U-1A (Otter).



SECTION A-A
SLOPING BULKHEAD TO STATION 155.0



SECTION B-B
STATIONS 155.0 TO 194.0



SECTION C-C
STATIONS 204.0 TO 264.0

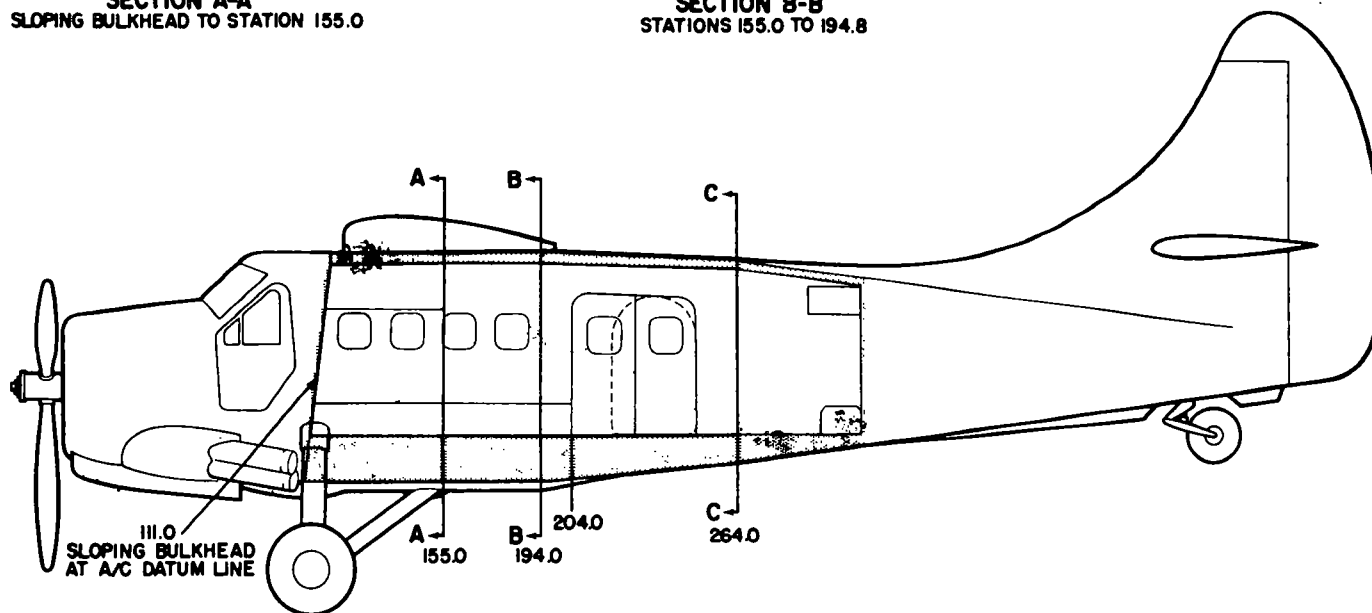
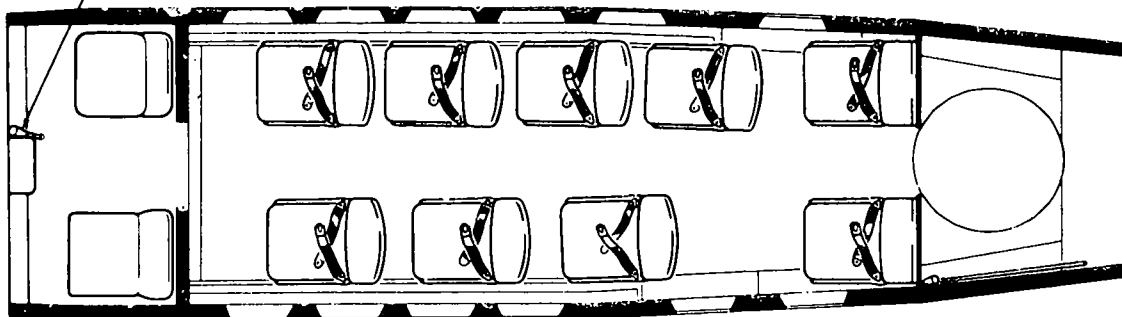


Figure 2-7. U-1A (Otter). Cabin dimensions.

COCKPIT RELIEF TUBE



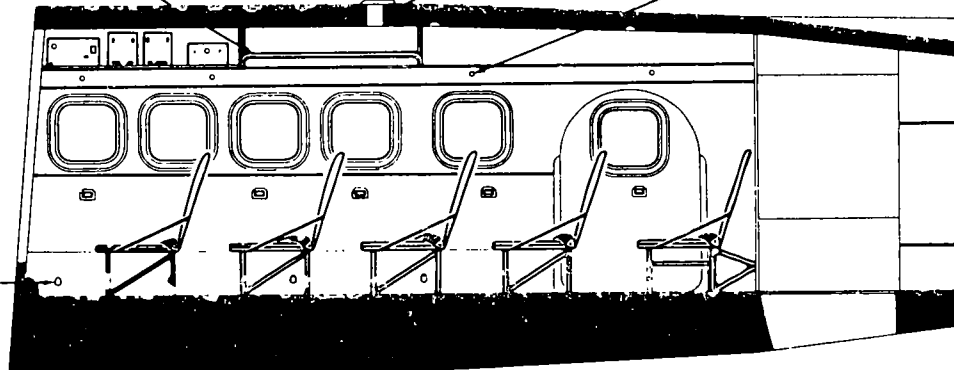
PLAN VIEW - COCKPIT AND CABIN

LUGGAGE RACK

EXHAUST VENTILATOR

VENTILATOR KNOB

HOT AIR OUTLET

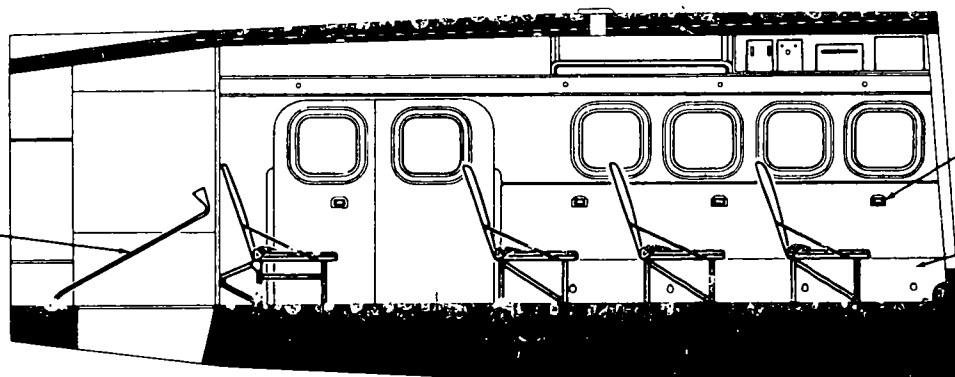


RIGHT-HAND SIDE VIEW - CABIN

CABIN RELIEF TUBE

ASH TRAY

HEATER DUCT



LEFT-HAND SIDE VIEW - CABIN

Figure 2-8. U-1A (Otter). Troop seating.

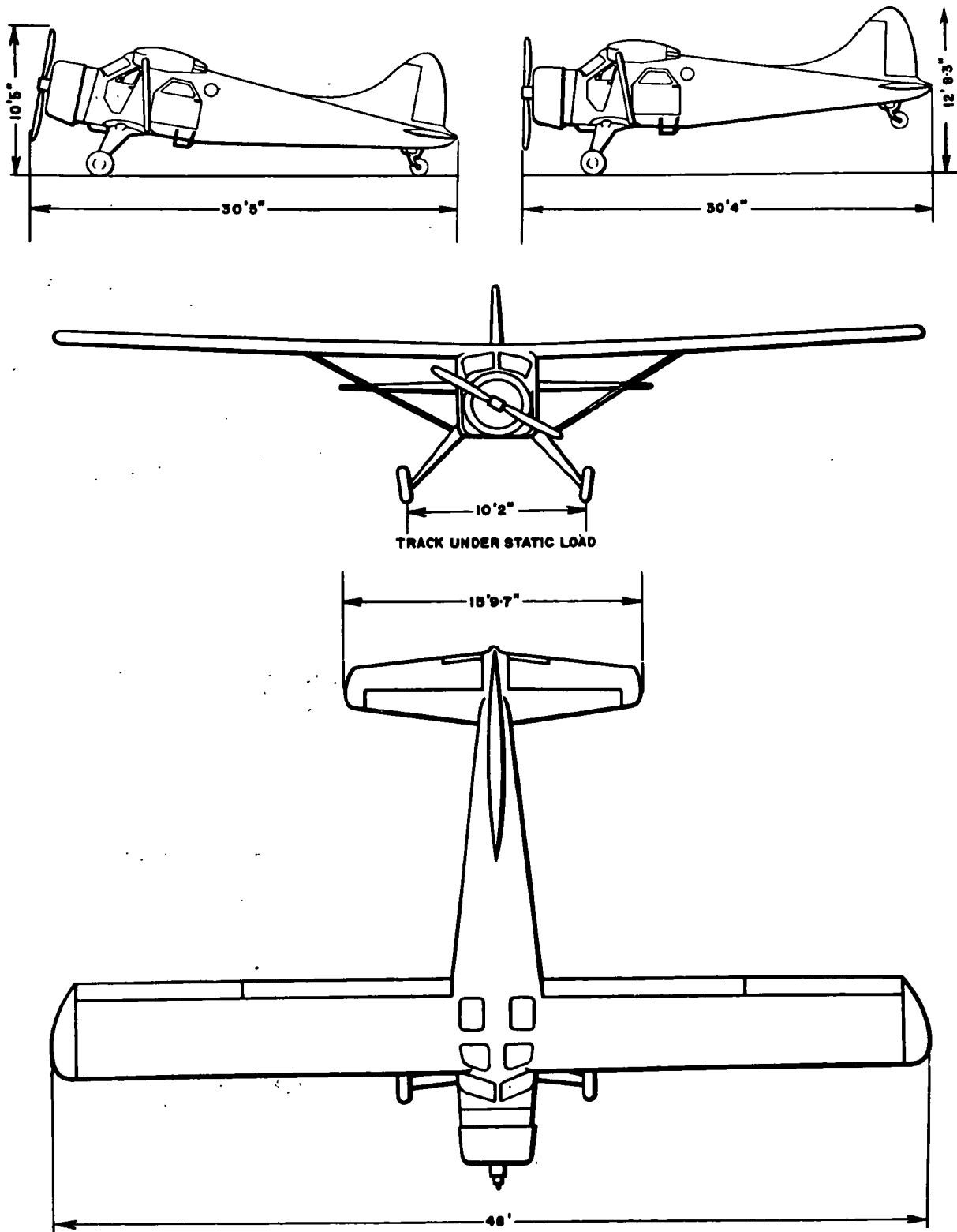


Figure 2-9. U-6A (Beaver).

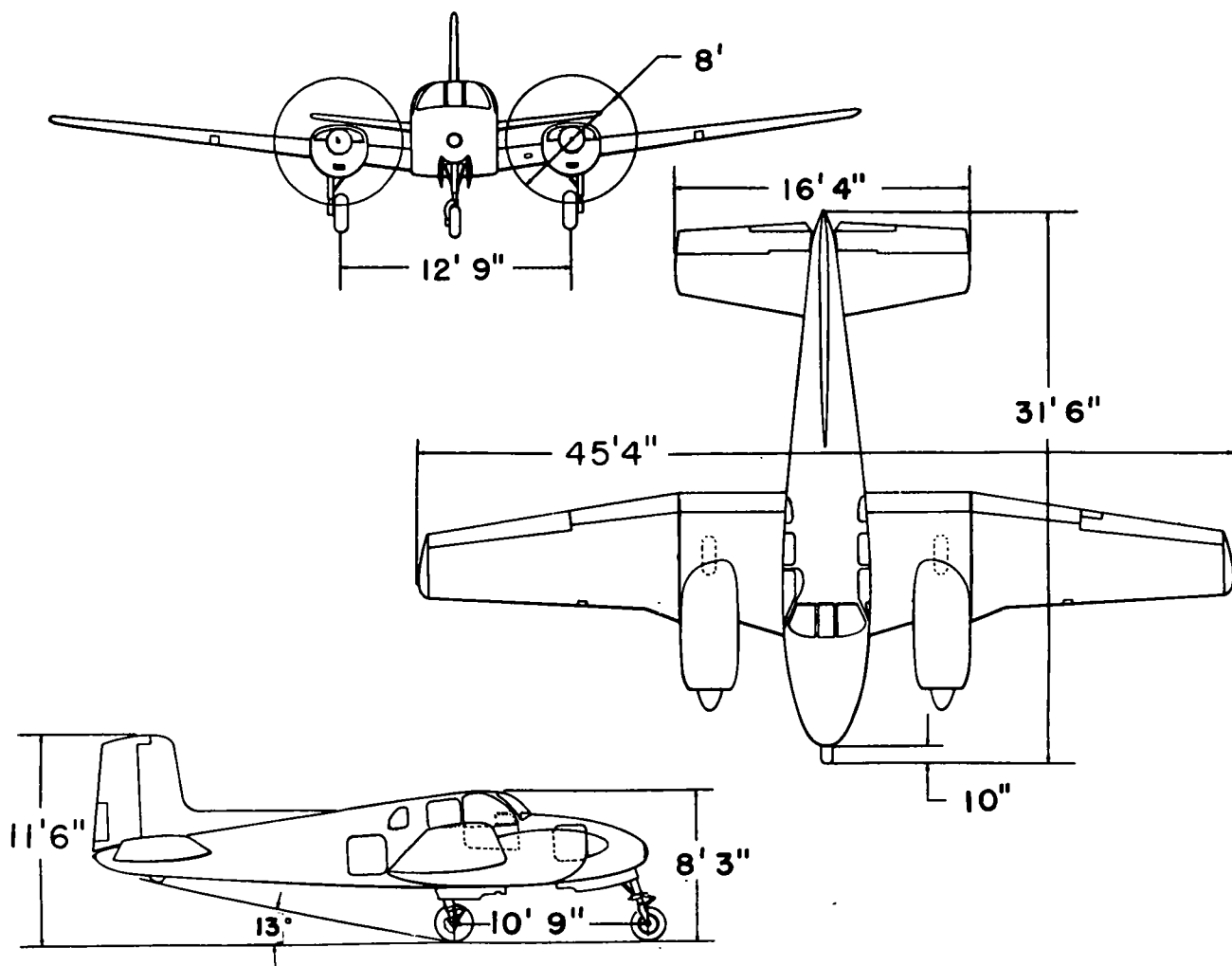


Figure 2-10. U-8D (Seminole).

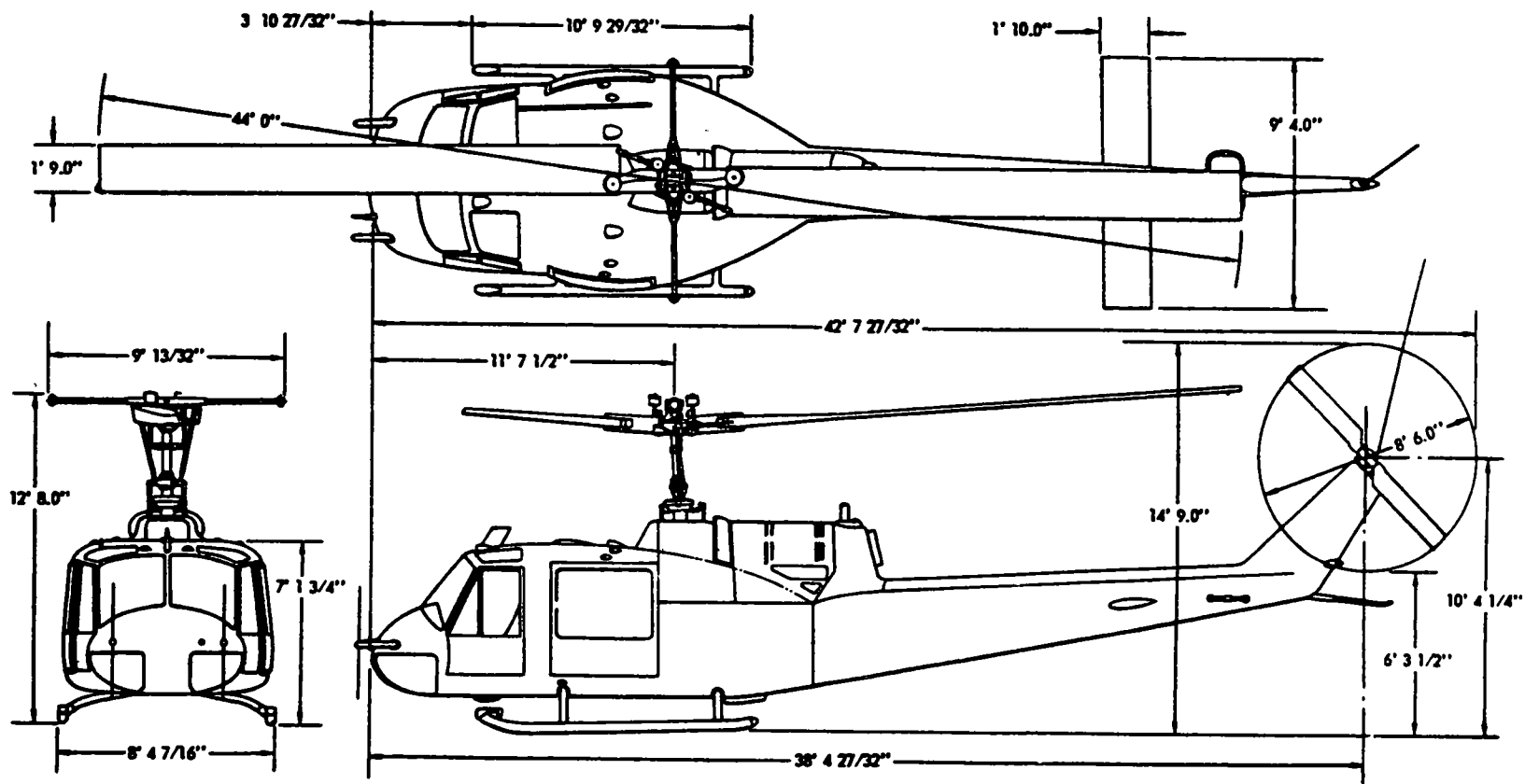
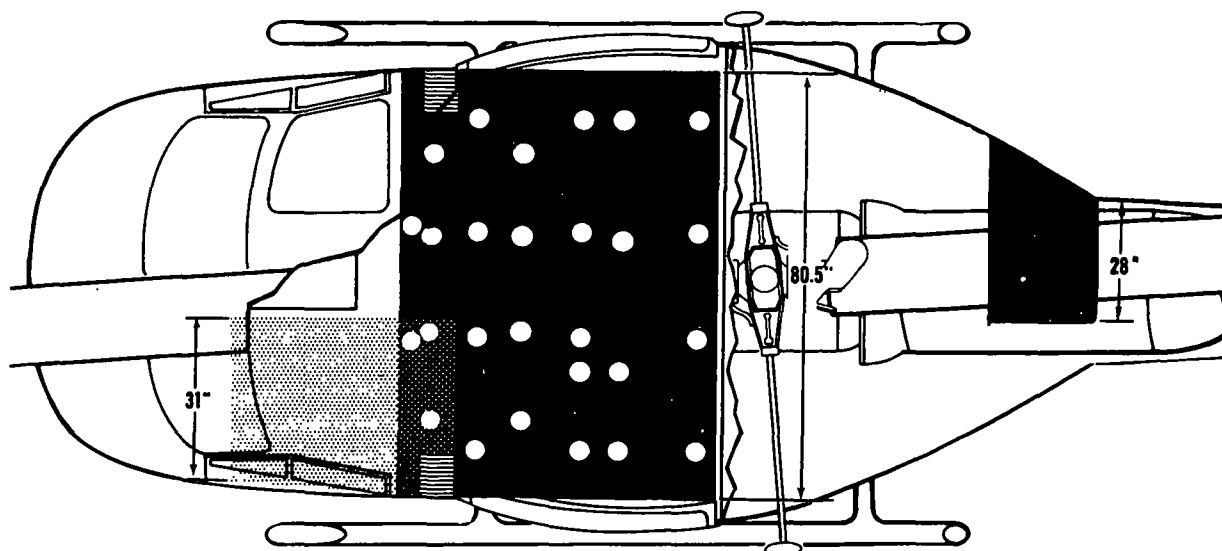


Figure 2-11. UH-1B (Iroquois).



CODE



1. Tie down fittings.



2. Cargo area, maximum loading dimensions.



3. Optional loading area, copilots seat removed.



4. Interior area above maximum package.



5. Floor obstruction. (Heater outlets)

NOTES:

- Cargo floor loading vs. G load factor

Lbs. Sq. Ft.	Safety Factor
300	1.0
150	2.0
100	3.0
- Tie down fittings, strength 1250 lbs. vertical, 500 lbs. horizontal load per fitting.

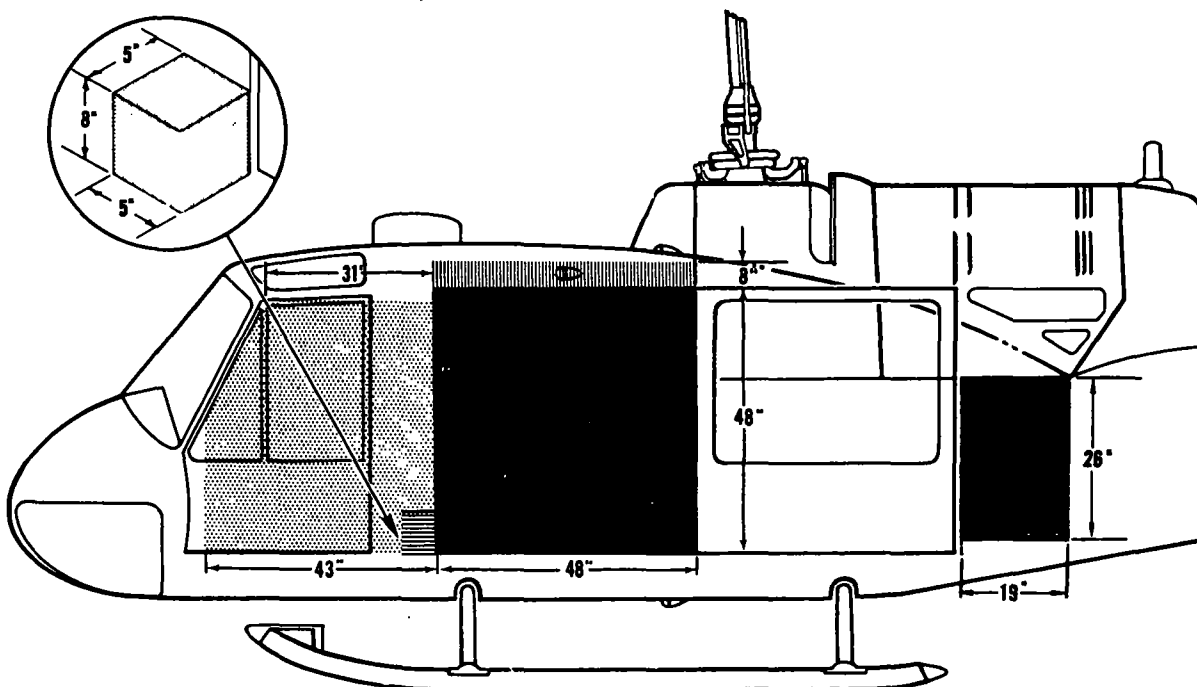
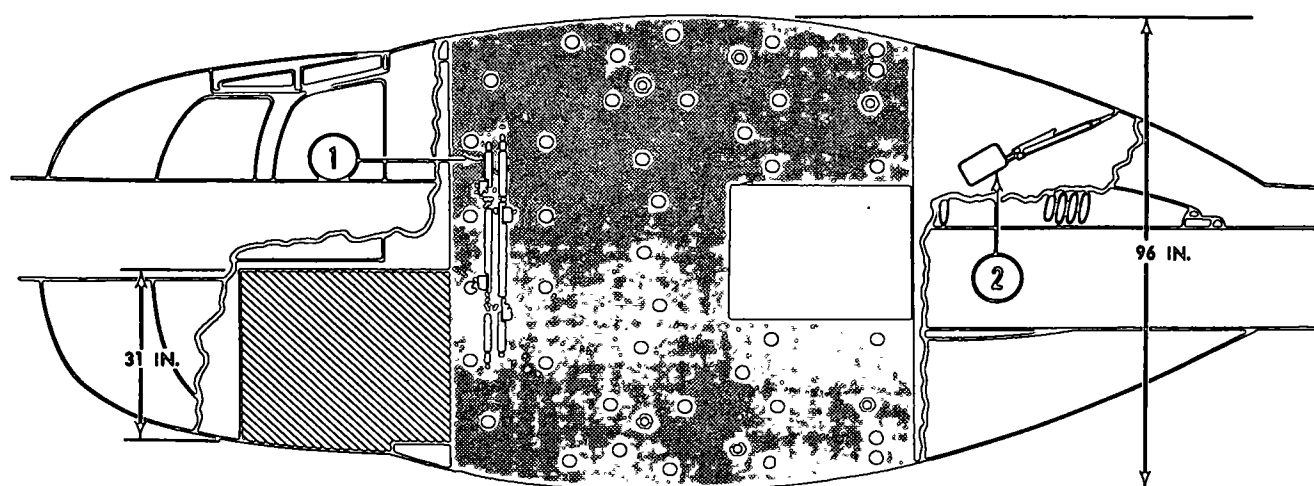
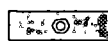


Figure 2-12. UH-1B, UH-1C (Iroquois). Cargo features.



CODE

- | | | | |
|---|--|---|----------------------|
|  | 1. Tie-down fittings. |  | 1. Stanchion Stowage |
|  | 2. Stanchion Fittings. |  | 2. Mirror Stowage |
|  | 3. Cargo area, maximum loading dimensions. | | |
|  | 4. Optional loading area, copilot's seat removed. | | |
|  | 5. Interior clearance above maximum package at G_c of cabin. | | |

NOTES:

1. Cargo floor loading vs G load factor

Lb	Sq Ft	Safety Factor
300		1.0
150		2.0
100		3.0
2. Tie-down fittings, strength 1250 lb vertical, 500 lb horizontal load per fitting.

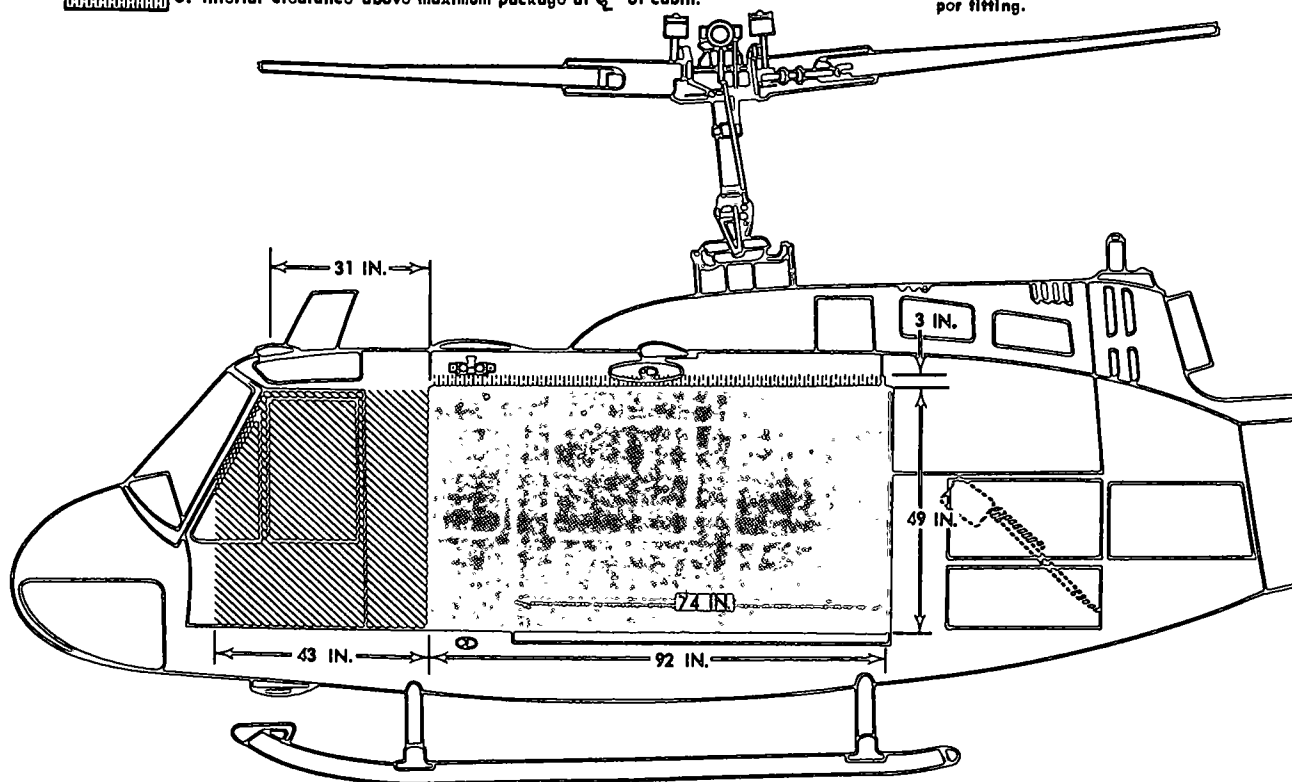


Figure 2-13. UH-1D, UH-1H (Iroquois). Cargo features.

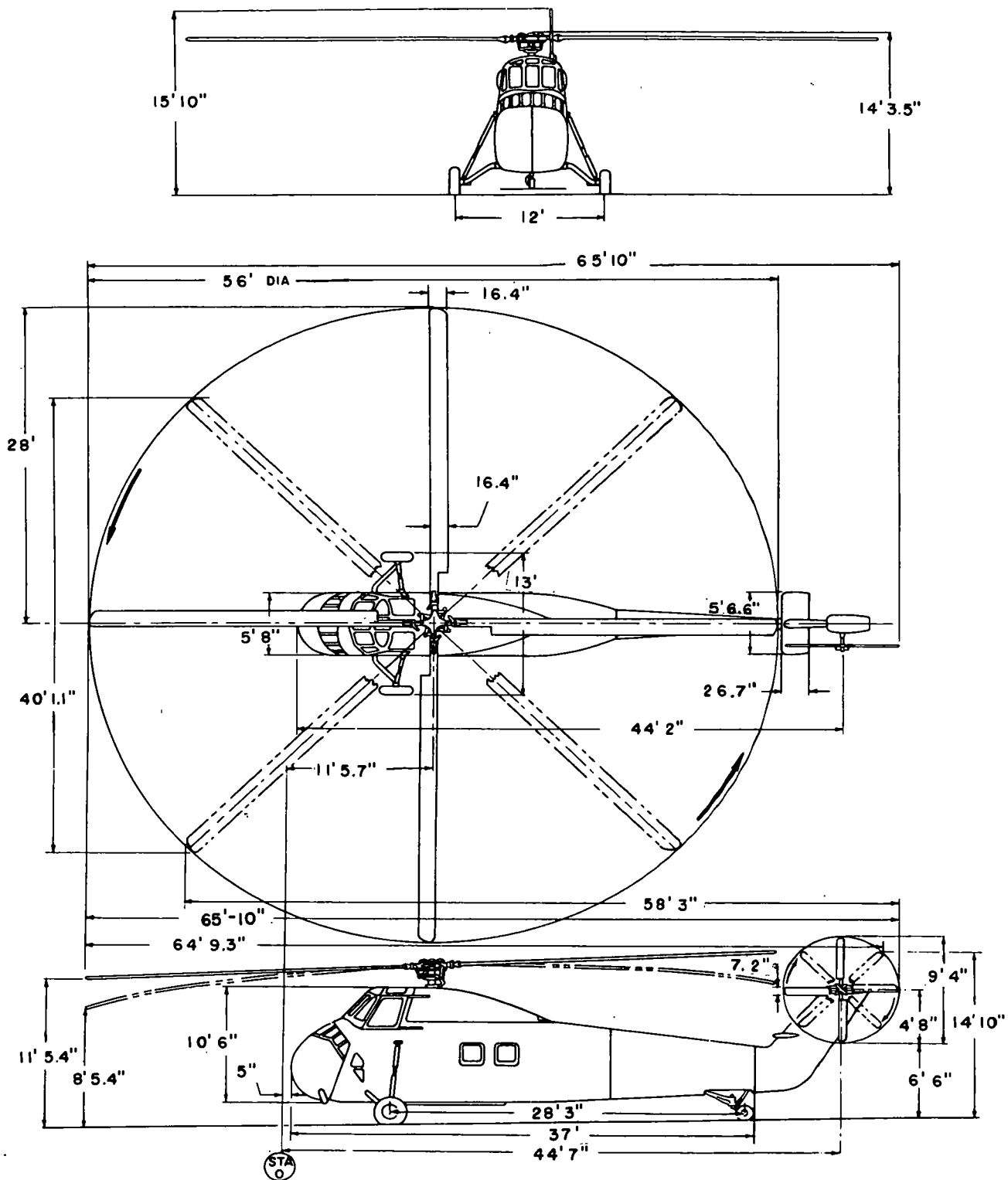


Figure 2-14. CH-34C (Choctaw).

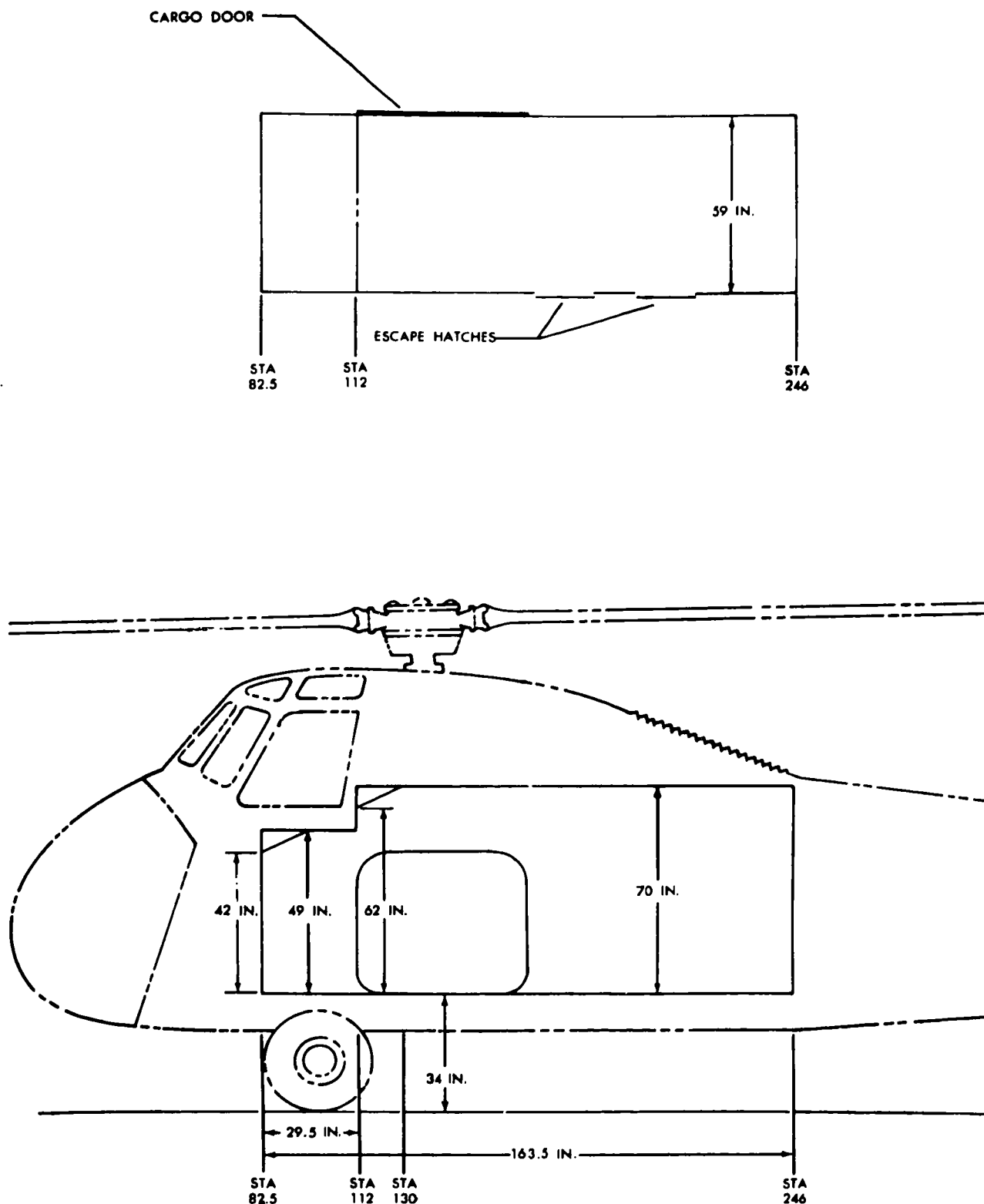


Figure 2-15. CH-34C (Choctaw). Cargo compartment dimensions.

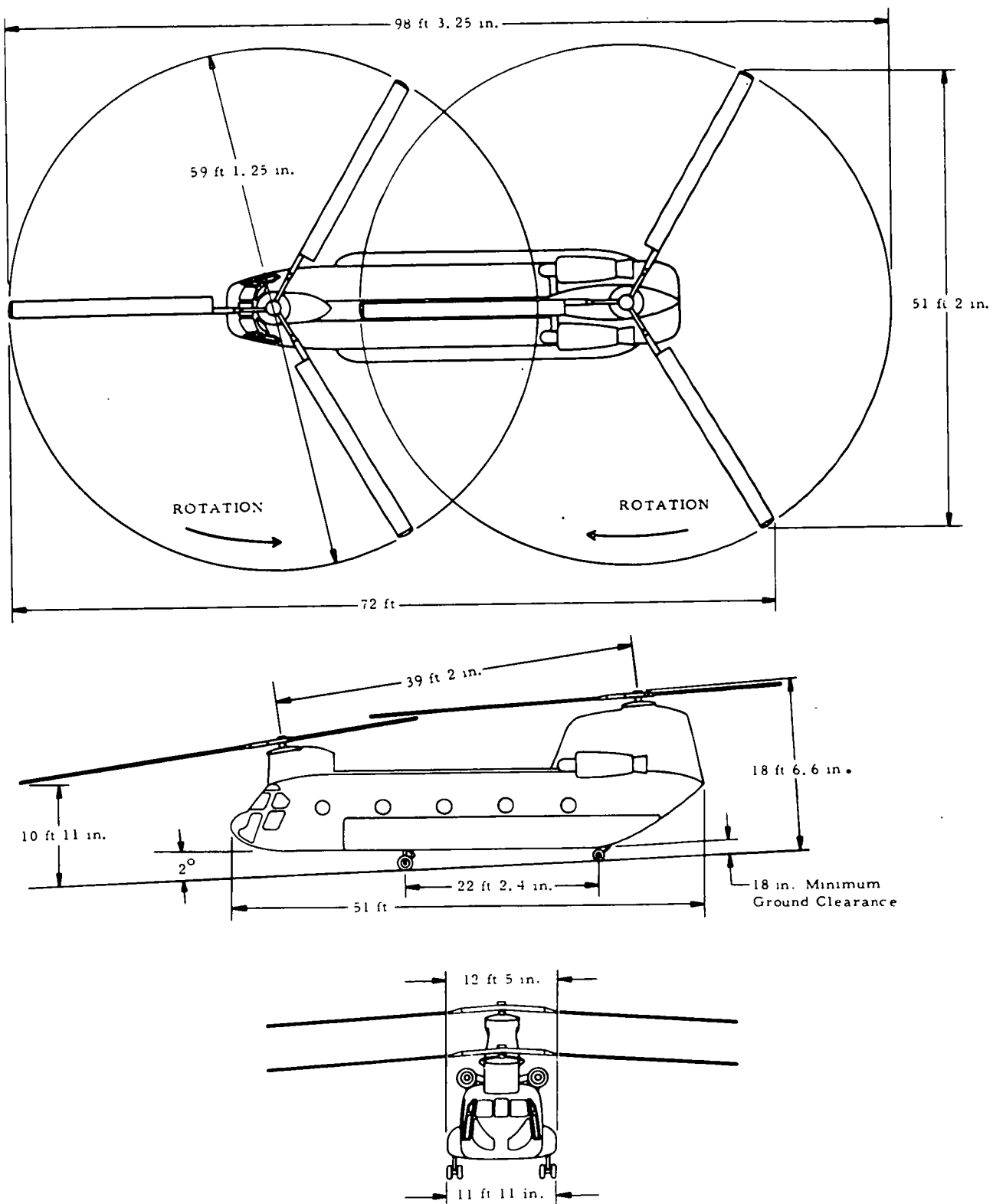


Figure 2-16. CH-47A (Chinook).

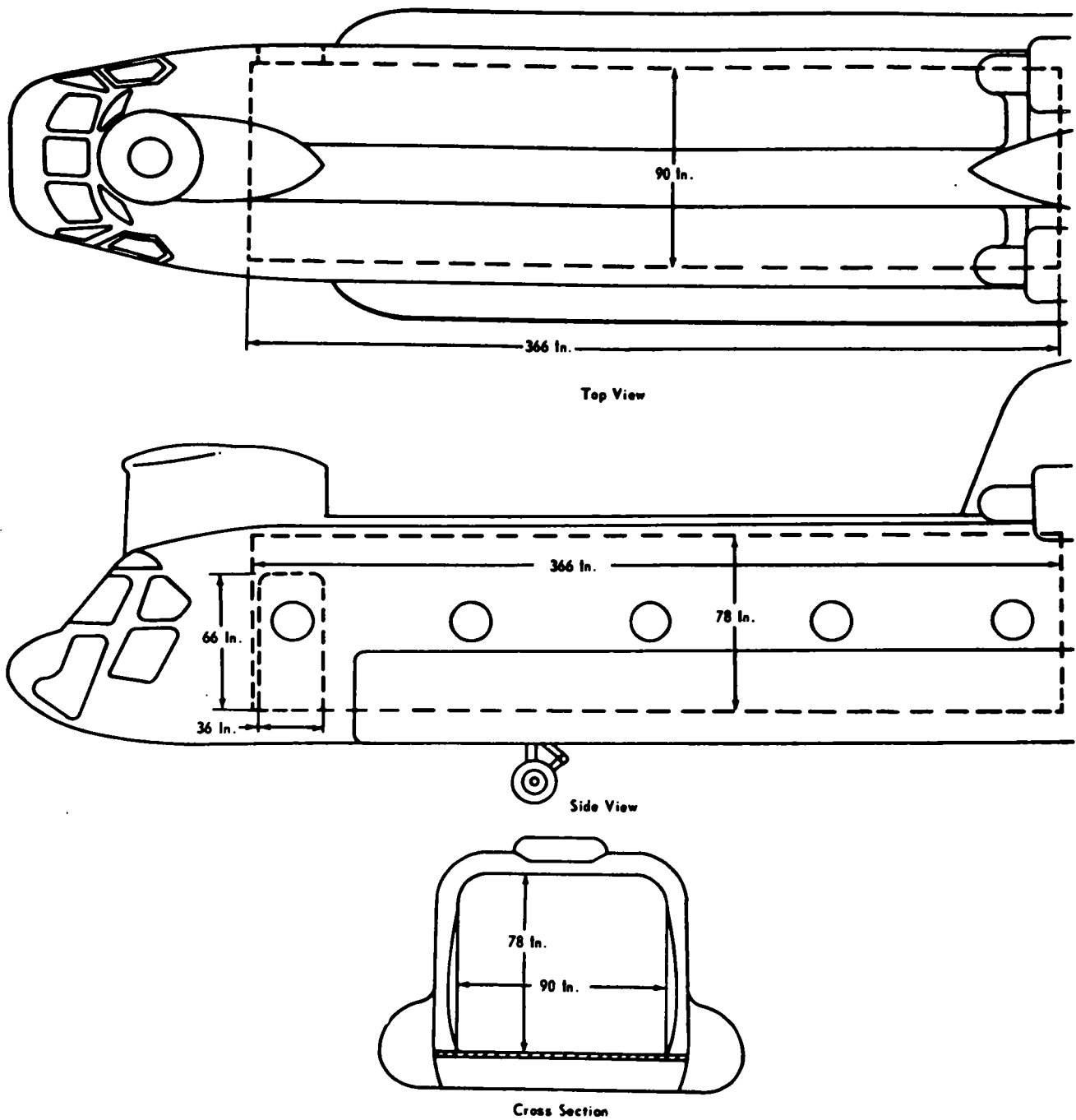


Figure 2-17. CH-47A, B, C, (Chinook). Cargo compartment.

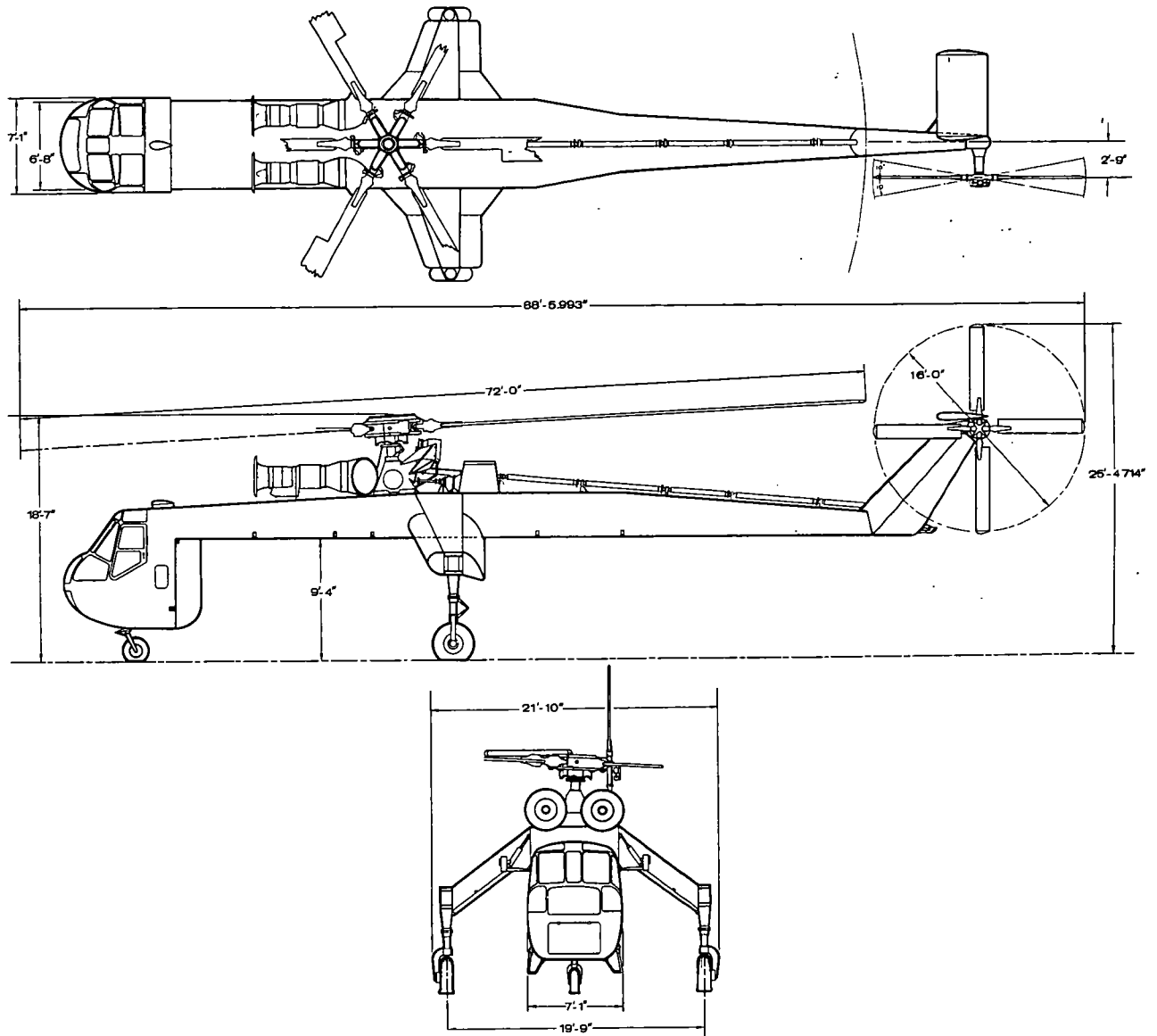
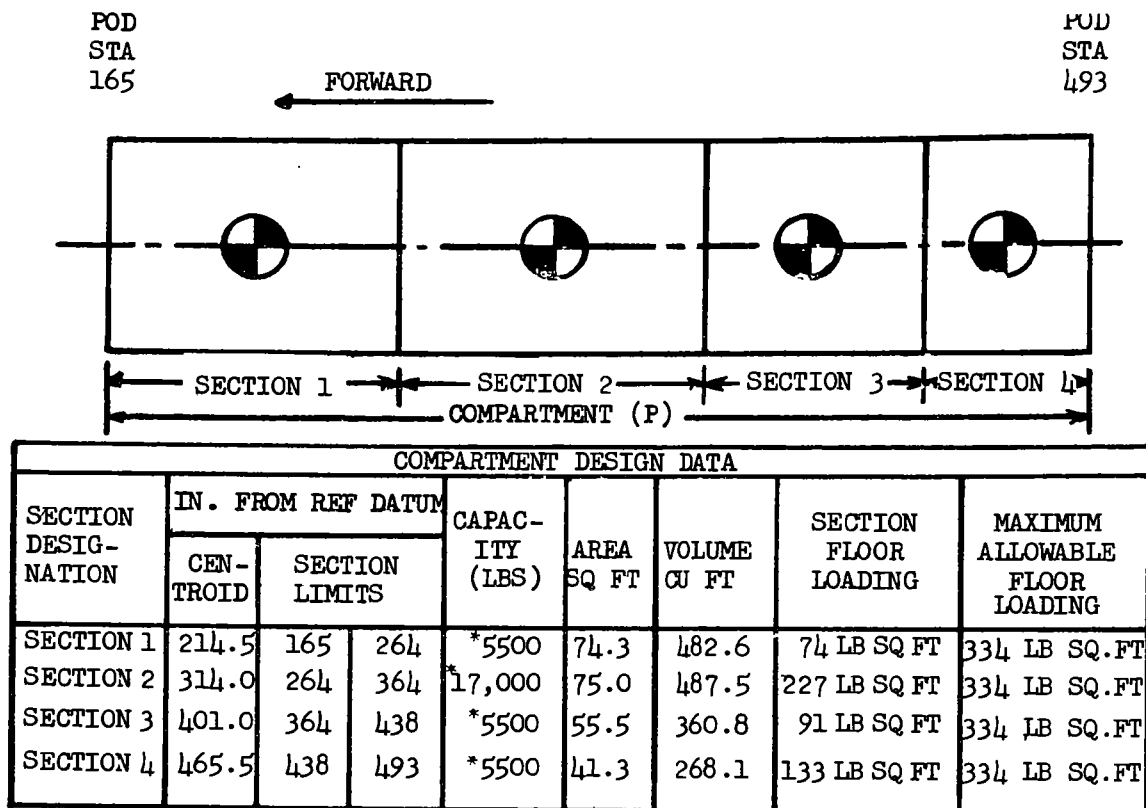


Figure 2-18. CH-54 (Sky Crane).



*NOTE: LOAD CARGO ON OR SYMMETRICALLY ABOUT THE CENTER LINE OF THE POD AT ALL TIMES.

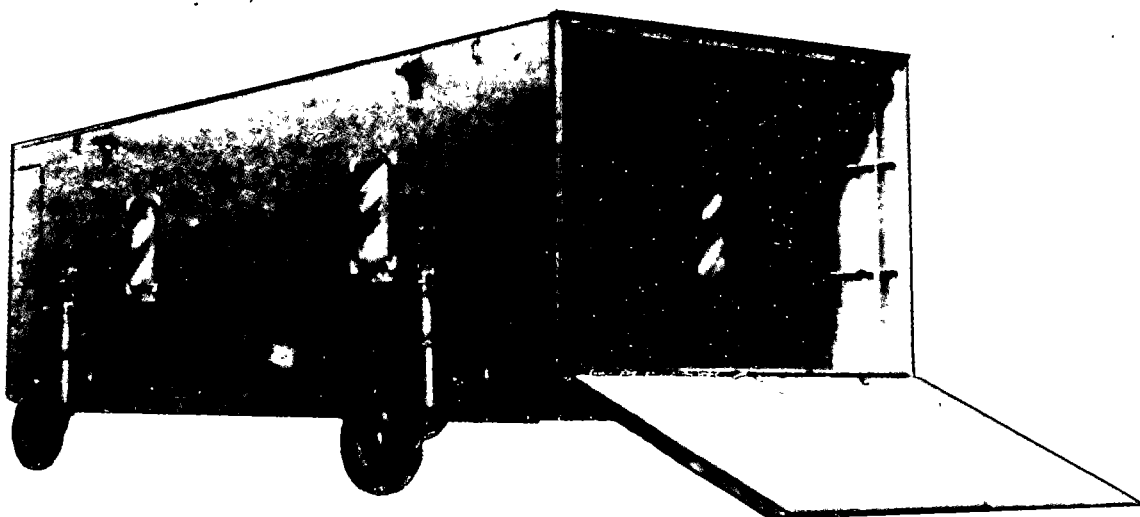


Figure 2-19. (Top) pod cargo loading information;
(bottom) detachable universal pod, CH-54.

★Section III. OPERATIONS

2-11. Outline Standing Operating Procedure for Air Movements

a. General. Amplification of command policies on use of air transportation (intratheater and intertheater), including responsibilities, utilization, and procedures in the employment of organic aviation units; responsibilities for coordination with Air Force aerial ports.

(1) *Submission of space requirements.* Responsibilities for, timing, format, procedures, and policies affecting submission of advance and firm space requirements for air movement of supplies and personnel.

(2) *Airspace assignments.* Controlling agency; procedures for application, space assignment, and use of space assignments; formats.

(3) *Air priorities system.* Controlling agency; procedures and responsibilities for application, determination, dissemination, and use of priorities; implementation of command policies and directives.

(4) *Aerial port calls.* Responsibilities and procedures for the issue of port calls for supply and personnel movements, implementation and execution of such calls.

(5) *Special movement control actions.* Special actions required to integrate movement control of air transportation with other applicable modes of transportation.

(6) *Loading and unloading of aircraft.* Policies, responsibilities, and procedures for loading and unloading troops, accompanied supplies, and equipment at air terminals.

(7) *Diversions and reconsignments.* Authority, procedures, and channels prescribed for effecting and executing diversions or reconsignments.

b. Supply Movements.

(1) *Designation for air movement.* Authority for, responsibilities, how accomplished and disseminated, actions to be taken.

(2) *Special packing requirements.* Special instructions for packing or preparing supplies for air movement. Responsibility for packing and inspecting before air movement.

(3) *Special marking.* Types, responsibilities for applying marking on containers and

for obliterating old markings.

(4) *Documentation.* Responsibilities and procedures for preparing and distributing established documents.

(5) *Airdrops and extractions.* Amplification of command policies and directives on packaging and delivery responsibilities, methods and procedures for obtaining and accomplishing airdrops, methods and responsibilities for marking landing or drop zones.

(6) *Records and reports.* Responsibilities and methods of maintenance of specific records and reference to reports to be submitted.

c. Personnel Movements.

(1) *Preparation for air movement.* Command policies and directives on procedures and requirements for preparing units and individuals for air movement.

(2) *Movement to air terminals.* Procedures and responsibilities for the movement of units and individuals to air terminals for air movement.

(3) *Documentation.* Preparation, distribution, and uses of established flight forms and documentation.

(4) *Records and reports.* Responsibilities and methods for maintenance of specific records and reference to reports to be submitted.

2-12. Outline Standing Operating Procedure for Air Transport Service (Air Force and Army Aviation)

a. General. Policies involved in control, operation, and maintenance of facilities, equipment, and installations; command responsibility; technical supervision required and agencies involved; responsibility for operational control.

b. Mission. Service to be provided by organic aviation units when made available for administrative movements, Air Force tactical airlift units, and other aircraft in direct support; extent of operation.

c. Functions.

(1) Scheduled and nonscheduled operations.

(2) Maintenance of equipment: responsibilities, procedures, facilities, inspections.

d. Operational Planning. Personnel, equipment, and supply requirements; capabilities and capacities; communication procedures.

e. Operations. Operational procedures and control; utilization of personnel, equipment, and facilities; priorities; coordination; documentation; records and reports; service to be given personnel and cargo; liaison established between aviation and user units.

f. Maintenance. Responsibilities and procedures for maintenance, regulations, reports, and records.

g. Supply. Responsibilities, authorized levels, procedures, and accounting methods for the Air Force.

h. Intelligence. Responsibility for collection, collation, evaluation and dissemination of air transportation intelligence.

i. Security. Responsibilities, disaster and defense plans, and equipment and supply security.

j. Records and Reports. Responsibilities: technical, operational, personnel, and stock records and reports.

k. Training. Responsibilities: unit and technical training.

2-13. Weight and Balance Terms

a. Aircraft Balance Limits. The maximum forward and maximum aft permissible locations of the aircraft center of gravity expressed as station numbers or as percentages of the mean aerodynamic chord (MAC). If these limits are exceeded, the aircraft will have unsatisfactory flight characteristics.

b. Center of Gravity (CG). The point about which an object would balance if supported at that point or the point at which the weight of an object or group of objects can be considered concentrated.

c. Reference Datum Line (RDL). An imaginary vertical line at or near the nose of the aircraft from which all horizontal distances are measured. Aircraft diagrams show this line as structural station zero.

d. Station Number. A number, generally

marked on the interior of an aircraft, indicating a plane extending across the fuselage of the aircraft parallel to the reference datum line and representing the distance from it in inches.

e. Arm. The horizontal distance in inches from the reference datum line to the center of gravity of an object.

f. Moment. The product of the weight of an item multiplied by its arm. Moment may be expressed in pound-inches; for example, 2 pounds (weight) $\times$ 10 inches (arm) = 20 pound-inches (moment).

g. Allowable Cabin Load—Allowable Cargo Load. The load, of either passengers or cargo, which an aircraft is considered capable of air-lifting safely over a given route under prescribed conditions. Expressed in terms of weight.

h. Basic Weight. The empty weight of an aircraft in its basic configuration, including all appointments, integral equipment, instrumentation, and trapped fuel and oil, but excluding passengers, cargo, crew, and fuel and oil.

i. Operating Weight. Basic weight of the aircraft plus oil, crew, crew's baggage, and mission equipment.

j. Ready-for-Loading Weight. Total aircraft, crew, oil, and fuel weight; or the gross weight less cargo; or the basic weight plus crew, oil, and fuel.

k. Maximum Allowable Gross Weight. The maximum allowed total weight of the aircraft prior to takeoff; the "basic weight" of the aircraft plus the crew, personnel equipment, special devices, passengers/cargo, and usable fuel and oil. This is limited by structure, power available, or landing load.

l. Maximum (Alternate) Gross Weight. A gross weight in excess of the design gross weight. The maximum alternate gross weight is normally used in combat operations, but does not afford any margin of safety.

2-14. Calculating Center of Gravity of a Loaded Aircraft

To determine the center of gravity (CG) lo-

cation of a loaded aircraft, it is first necessary to obtain the weight and CG (moment) of the aircraft ready for loading.

a. *Procedures.* The procedures for computing the center of gravity of a loaded aircraft are as follows:

(1) Calculate for moment. $\text{Weight} \times \text{Arm} = \text{Moment}$.

(2) List aircraft ready-for-loading weight times the ready-for-loading CG = moment.

(3) List weight times the arm of each cargo item = moment.

(4) Add all the weights and enter the total.

(5) Add all the moments and enter the total.

(6) Divide the total moment by the total weight; round off any decimals.

This figure is the station number at which the aircraft is balanced. If the figure does not fall within the safe flight limits, the load or a part of it must be relocated and aircraft balance recomputed.

b. *Example.* Sample problem (C-141 aircraft): The C-141 aircraft is loaded with three M35, 2 1/2 ton trucks, each weighing 13,700 pounds, and six passengers (1,800 pounds). All trucks are positioned, facing the rear of the aircraft, with the CG of truck No. 1 at station No. 630; The CG of truck No. 2 at station No. 920; the CG of truck No. 3 at station No. 1200; and the CG of the six passengers at station No. 930. Weight of aircraft ready for loading is 271,000 pounds, with its CG at station No. 915.

$\text{Weight} \times \text{Arm} = \text{Moment}$.

Weight of aircraft ready for loading $\times$ CG of aircraft ready for loading.

Weight of one truck $\times$ Station No. 630.

Weight of one truck $\times$ Station No. 920.

Weight of one truck $\times$ Station No. 1200.

Weight of passengers $\times$ Station No. 930

271,000 $\times$ 915 = 247,965,000

13,700 $\times$ 630 = 8,631,000

13,700 $\times$ 920 = 12,604,000

13,700 $\times$ 1200 = 16,440,000

1,800 $\times$ 930 = 1,674,000

313,900 (total weight) 287,314,000
(total moment)

Total moment = 287,314,000

Total weight = 313,900 = 915.3 or 915

Station No. 915 is the CG of the loaded aircraft. The CG limits for safe flight for the C-141 are 906.7 to 948. The aircraft balanced at station No. 915 is safe for flight.

2-15. Air Movement Designator

This combination of code letters and numbers is assigned by the issuing agency to identify and indicate precedence of traffic movement within each service's allocation (AR 59-8 and para 7-20). Each air movement designator consists of code symbols in sequence as shown in the following example and as explained below.

	SUU	TAW	3EL	GF	6	
Origin	.....					Month of shipment
Destination	.....					Shipping agency
Priority	.....					

Type of Traffic

a. *SUU*—Indicates the MAC airport of origin of the traffic; in this example, "Travis AFB."

b. *TAW*—Indicates the MAC airport of destination of the traffic; in this example, "Tachikawa."

c. *3*—Indicates the priority assigned to the traffic movement; in this example, "Priority 3" (para 2-16).

d. *EL*—Indicates the type of traffic (i.e., whether passenger or cargo moved; in this example, "Passenger—Emergency leave").

e. *GF*—Indicates the sponsoring department in whose interest the traffic is being moved; in this example, "The Department of the Army."

f. *6*—Indicates the month in which the traffic is to be moved; in this example, "June."

2-16. Cargo Priorities

MILSTAMP Transportation Priority	MILSTRIP Issue Priority Designator
1	1 through 3
2	4 through 8
3	9 through 15

2-17. Restraint

a. *Restraint Safety Factor (RSF)*. A numerical factor developed by the designer of a particular aircraft. The restraint safety factor

multiplied by the weight of the cargo gives the total thrust or force that must be compensated for or restrained against in an aircraft.

b. Cargo Tiedown Fitting Pattern. The location and spacing of the cargo tiedown fittings in the floor, ceiling, or walls of an aircraft.

c. Rated Strength. The safe load capacity of a cargo tiedown device including an applied safety factor.

d. Effective Angle. Angle of tiedowns used to secure cargo to prevent movement in multiple directions.

e. Restraint Device. Straps, cable, or chains used to apply the required restraint to cargo and generally referred to as tiedown devices. (Rope may be used only when special devices are not available.)

f. General Cargo. Cargo which is susceptible to loading in general, nonspecialized storage areas, e.g., boxes, barrels, bales, crates, packages, bundles, and pallets.

2-18. Computing Required Restraint

a. Restraint Safety Factors. The restraint safety factor (RSF) is a numerical factor established by the designer of an aircraft. The RSF is sometimes expressed in G's acting on a given load. The RSF multiplied by the weight of the cargo gives the amount of thrust which must be offset with tiedowns. For example, when a C-5 stops abruptly, tiedowns must withstand a forward thrust equal to three times the weight of the cargo. Accordingly, a 1,000-pound load requires 3,000 pounds restraint to withstand forward thrust. Restraint safety factors are determined by certain characteristics of the aircraft—acceleration during take-off, stability during flight, deceleration during landing, and the type of landing field for which it is designed. Aircraft with a greater forward thrust factor require a greater forward RSF. For instance, the C-130 has more of a forward thrust factor than the C-5 because it can stop in a very short distance on unimproved fields.

b. Rated Strength of Tiedown Devices. The rated strength (RS) and characteristics of the common type of tiedown devices must be known to determine the kind of device needed. The rated strength includes an applied safety factor. Figure 2-20 illustrates these devices. Appropriate types of tiedown devices with the highest rated strength should be selected thereby providing the needed restraint with the least number of devices.

c. Types of Tiedown Devices (fig 2-20).

(1) *A-1A*—An 18-foot length of cotton webbing with two metal hooks, one stationary and one movable, and a quick-release adapter. It has a 1,250-pound rated strength and is used for lashing general cargo. Although still in use, this device is gradually being phased out.

(2) *CGU-1/B*—A device similar to the MC-1. It is an improvement over the MC-1 and will eventually replace it. It has a rated strength of 5,000 pounds and consists of a web nylon strap approximately 20 feet long with a fixed snaphook on one end and a movable hook on the other. The movable hook end of this device, unlike the MC-1, has a ratchet system for tensioning the device. It weighs approximately 3.75 pounds.

(3) *C-2*—A length of chain with an L-shaped hook at one end and a detachable quick-release jaw and tightening mechanism at the other end. It has a 10,000-pound rated strength and is used for all vehicles.

(4) *D-1*—A steel chain with a hook at one end and a detachable jaw and turnbuckle fitting at the other. It has a 25,000-pound rated strength and is used primarily on heavy vehicles.

(5) *MB-1*—Similar to the C-2 but with a hook which is engaged with the tiedown fitting in place of the jaws on the C-2. It is used with the same chain as the C-2. It has a 10,000-pound rated strength.

(6) *MB-2*—Similar to the D-1. It has a heavy hook that is engaged with the tiedown fitting and is used with the same hooked chain as the D-1 except that it has a quick-release device. It has a 25,000-pound rated strength.

(7) *MC-1*—A nylon web strap with two metal hooks, one stationary and one movable.

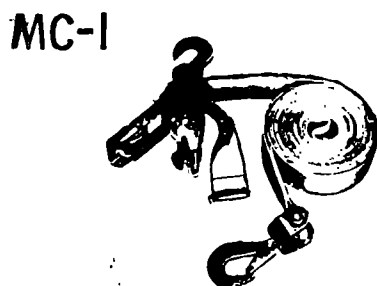
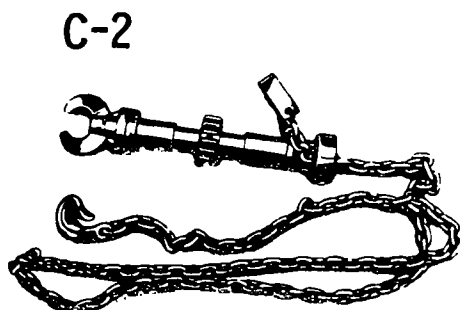
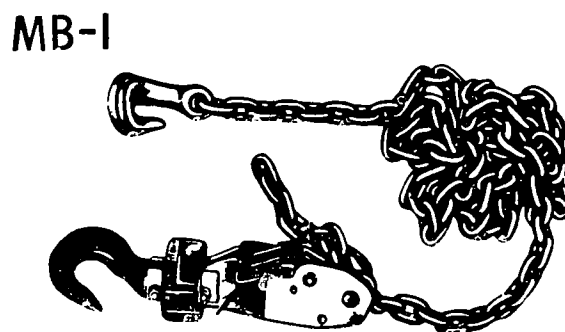
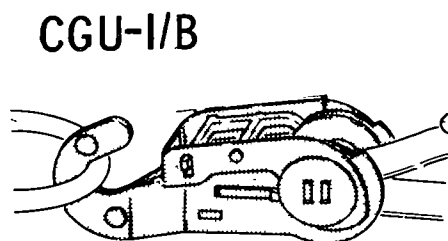
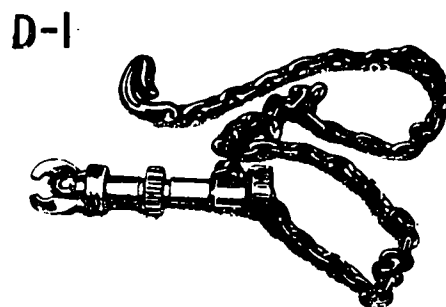
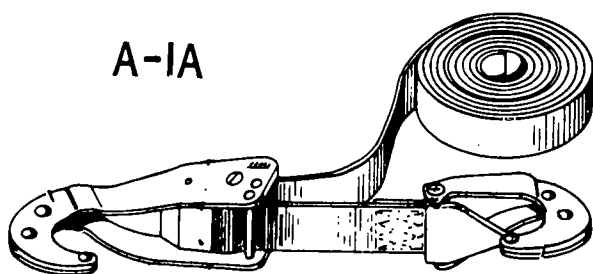


Figure 2-20. Types of tiedown devices.

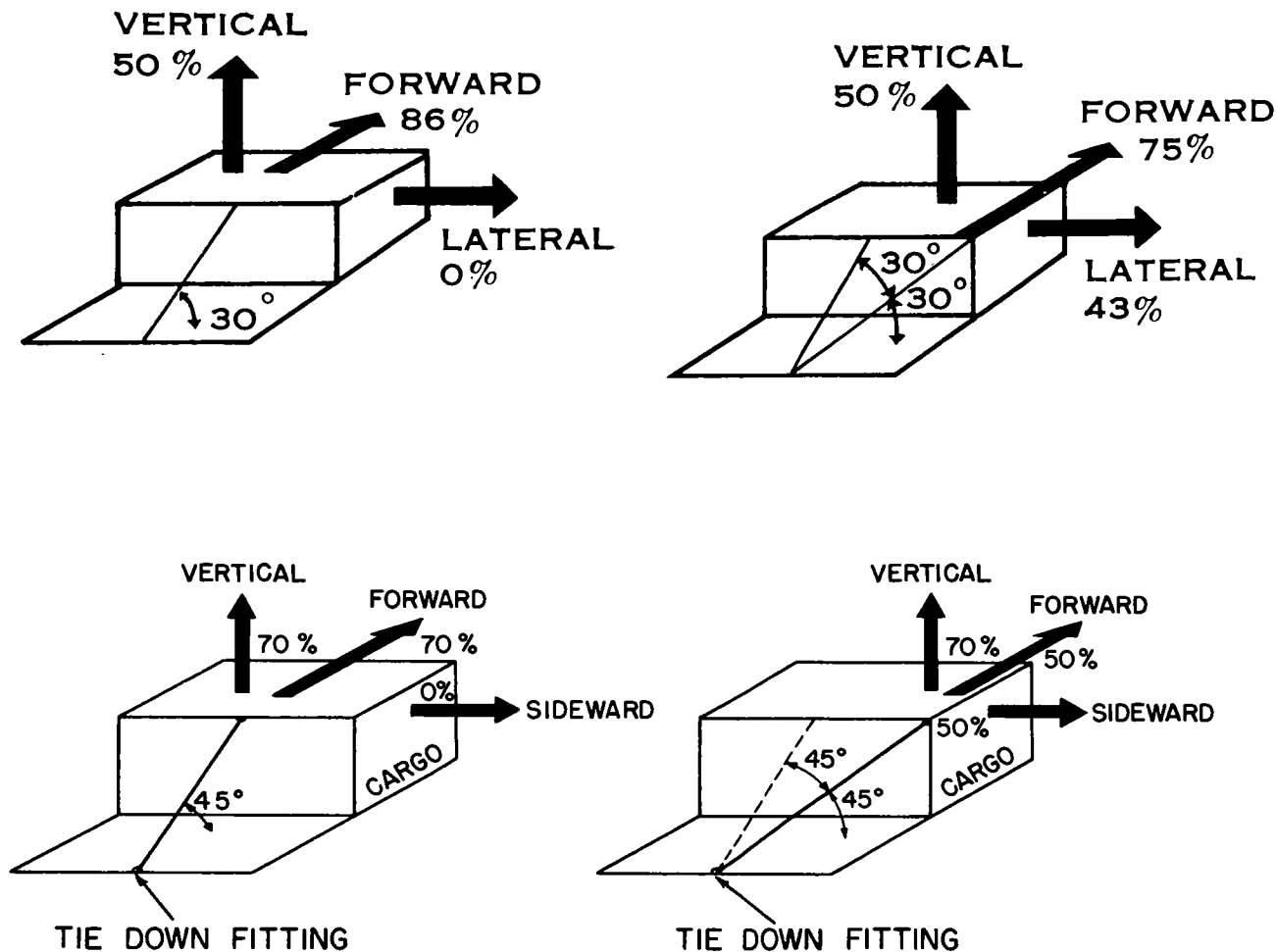


Figure 2-21. Percentage value of tiedowns applied at 30° and 45° angles.

It is similar in appearance to the A-1A and has a 5,000-pound rated strength.

(8) *Manila rope*—Usually an 18-foot length of 1/2-inch manila hemp rope. It has a safe working capacity of 660 pounds with a safety factor of 4, although its rated strength is 2,000 pounds.

2-19. Tiedown Angles

(fig 2-21)

a. Tiedown chains attached to a load at a point above the floor form two angles that can be measured—a floor angle and a longitudinal plan angle. The floor angle (sometimes called the vertical angle) is the angle between

the chain and the floor. The longitudinal angle is the angle between the chain and a line which runs fore and aft in the cargo compartment through the attachment point.

b. Tiedown chains attached at floor and plan angles of 30 degrees provide the best compromise for adequate restraint of cargo in all directions. Frequently it will not be possible to use 30-degree angles, and other arrangements will be necessary. In these cases, try to place the tiedowns as close to a 30-degree angle as possible. Increasing the floor angle while keeping constant plan angles will provide a higher value of vertical restraint but will reduce the amount of longitudinal and lateral restraint.

PERCENTAGE RESTRAINT CHART																		
NOTE: 1. Angles across the top are those formed between the tie-down device and the cabin floor. 2. Angles down the side are those formed between the tie-down device and the longitudinal axis of the aircraft. * Vertical restraint is related only to the angle between the tie-down device and the cabin floor. The lateral angle has no bearing on it. ** The toned area indicates the "best compromise" position																		
		5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°
5°	VERTICAL*	8.7	17.4	25.9	34.2	42.3	50.0	57.4	64.3	70.7	76.6	81.9	86.6	90.6	93.9	96.6	98.5	99.6
	LONG.	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3	8.7
10°	LAT	8.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5	0.8
	LONG.	98.1	97.0	95.2	92.6	89.2	85.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1	8.6
15°	LAT	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0	1.5
	LONG.	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8	8.4
20°	LAT	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5	2.3
	LONG.	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6	8.2
25°	LAT	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9	2.9
	LONG.	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8	7.9
30°	LAT	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7
	LONG.	86.3	85.3	83.7	81.4	78.5	**74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1	7.5
35°	LAT	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4
	LONG.	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1
40°	LAT	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9	4.9
	LONG.	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3	6.7
45°	LAT	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.6
	LONG.	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2
50°	LAT	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2
	LONG.	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.6
55°	LAT	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3	6.7
	LONG.	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9	4.9
60°	LAT	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1
	LONG.	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4
65°	LAT	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1	7.5
	LONG.	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7
70°	LAT	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8	7.9
	LONG.	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9	2.9
75°	LAT	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6	8.2
	LONG.	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5	2.3
80°	LAT	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8	8.4
	LONG.	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0	1.5
85°	LAT	98.1	97.0	95.2	92.6	89.2	85.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1	8.6
	LONG.	8.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5	0.8
	LAT	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3	8.7

Figure 2-22. Percentage restraint chart.

2-20. Percentage Restraint Chart

The percent value of a restraint device for angles from 5 to 85 degrees is illustrated at figure 2-22.

2-21. Strength of Tiedown Fittings

a. A chain is only as strong as its weakest link. Tiedown devices and tiedown fittings of the same rated strength should be used together. For example, a 10,000-pound tiedown device attached to a 5,000-pound floor fitting has a holding strength of only 5,000 pounds.

b. For both forward and rearward restraint, devices should be attached in a regular pattern by using corresponding points of attachment on opposite sides of the equipment and corresponding tiedown fittings on each side of the cargo floor centerline.

2-22. Computing Number of Tiedowns Required

a. Two elements used for computing the exact number of tiedowns required in a given situation are—(1) force to be secured, and (2) effective holding strength of one device. The first is the product of the cargo weight and restraint safety factors. The second is the product of the rated strength of the tiedown device and the percent effectiveness of the angle of tie. The first element divided by the second makes up the formula for computing the number of tiedowns required in any situation.

$$\frac{\text{Force to be secured}}{\text{Effective holding strength}} = \text{Number of tiedowns required.}$$

b. Specific working formulas for each angle of tie are as follows:

(1) *Straight 45° angle of tie (compute for forward and lateral).*

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 70\%} = \text{Number of tiedowns}$$

(2) *45° × 45° angle of tie (compute for forward and aft).*

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 50\%} = \text{Number of tiedowns}$$

(3) *Straight 30° angle of tie (compute for forward and lateral).*

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 86\%} = \text{Number of tiedowns}$$

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 50\%} = \text{Number of tiedowns}$$

(4) *30° × 30° angle of tie (compute for forward and aft).*

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 75\%} = \text{Number of tiedowns}$$

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 43\%} = \text{Number of tiedowns}$$

EXAMPLE: C-130 aircraft

Restraint "G" or safety factor (RSF)

Forward	*8.
Aft	1.5
Side	1.5
Vertical	2.

*4 RSF may be used when passengers are not seated forward of cargo.

¾-ton truck (5,687 pounds) plus cargo (2,000)
10,000-pound tiedown devices
30° × 30° angle of tie

$$\frac{7,687 \text{ pounds} \times 8 \text{ RSF}}{10,000 \text{ pounds} \times .75} = \frac{61,496}{7,500} = 8.19 \text{ or } 10 \text{ devices for forward restraint}$$

$$\frac{7,687 \text{ pounds} \times 1.5 \text{ RSF}}{10,000 \text{ pounds} \times .75} = \frac{11,530}{7,500} = 1.53 \text{ or } 2 \text{ devices for aft restraint}$$

2-23. Typical Loads

See TM 55-450-10-series or TM 1-(transported acft)-S-series for typical loads.

2-24. Standard Parachutes and Carrying Capacities

Parachute	Diameter (ft)	Maximum load capability (lb)
G-12D	64	2,200
G-13	24.25	500
G-11A	100	3,500
T-7A	28	300

2-25. Aerial Delivery Containers and Typical Loads

Container	Average safe load (lb)	Typical load
A-7A -----	500	Packaged nonfragile supplies
A-21 -----	500	Fragile and nonfragile supplies
A-22 -----	2,200	Fragile and nonfragile supplies
A-22 (G-12D) -----	750	Fragile and nonfragile supplies

2-26. Loading or Unloading Time for Army Aircraft

a. Rotary-Wing Aircraft.

- (1) Troops—3 minutes.
- (2) Casualties—10 minutes.
- (3) Cargo, in fuselage—5 to 25 minutes, depending on the type cargo and aircraft.
- (4) Cargo, external load—30 seconds.
- (5) Refueling—
 - (a) Observation (OH-6, OH-13, OH-23, and OH-58)—7 minutes.
 - (b) Utility (UH-19 and UH-1)—10 minutes.
 - (c) Light transport (CH-34)—15 minutes.
 - (d) Medium transport (CH-47 and CH-54)—20 minutes.

b. Fixed-wing Aircraft.

- (1) Troops—approximately 2 to 3 minutes, depending on aircraft.
- (2) Casualties—10 minutes.
- (3) Cargo, in fuselage—
 - (a) Load—10 to 30 minutes, depending on cargo.
 - (b) Unload—5 to 15 minutes.
- (4) Cargo, external load—
 - (a) Load—10 minutes.
 - (b) Air-landed—10 minutes.
 - (c) Parachute—30 seconds.
 - (d) Free fall.
- (5) Refueling—
 - (a) Observation, light (O-1)—5 minutes.
 - (b) Utility (U-6)—8 minutes.
 - (c) Utility (U-1A)—15 minutes.
 - (d) Utility (U-8)—10 minutes.

2-27. Aircraft Landing Sites

See FM 57-35, FM 1-100, and TM 5-330.

2-28. Estimating Army Aircraft Movement Capability

a. *General.* To assess capability to move personnel and supplies by Army aircraft, the analyst must consider the various factors involved. Some or all of the factors will apply to a particular problem. Factors involved and methods of making capability estimates are given in *b* and *c* below.

b. *Factors Involved.* Depending upon the nature of a particular mission, the analyst must consider the following:

- (1) *Type and number of aircraft involved.*
- (2) *Loading.*
 - (a) Weight of cargo and lift capability (payload) of aircraft.
 - (b) Configuration of cargo in relation to size of cargo compartment and cargo compartment doors.
 - (c) Sling loads for helicopters.
 - (d) Wing loads for fixed-wing aircraft.
- (3) *Hours of daily operation (flying hours).*
 - (a) Helicopters—4.
 - (b) Fixed-wing aircraft—6.

(4) *Availability.* Availability is affected by the adequacy and efficiency of maintenance and supply and by the relative location of operating and service units. The average availability of aircraft on hand for sustained and short-term operations is shown below.

	Sustained (percent)	Short-term (percent)
Fixed-wing aircraft -----	75	90
Helicopters -----	67	90

(5) *Aircraft requirement.* The number of aircraft sorties required to accomplish a mission is determined by two factors—the basic requirement and the type of operation.

(a) *Basic requirement.* The number of aircraft needed to meet the basic requirement is obtained by dividing the total tonnage to be moved by the payload of one aircraft of the type to be used in the operation.

(b) *Type of operation.* The basic air-

craft requirement figure has to be adjusted according to the variable factors involved. The most common variable factors are—

1. *Distance.* Distance causes the fuel and payload relationship to vary inversely. When the operation exceeds 50 miles (80 kilometers), the basic aircraft requirement should be increased approximately 7 percent for each 20-mile (32-kilometer) increment.

2. *Sustained operation.* In a sustained operation, the basic number of aircraft required should be increased by 50 percent.

3. *Combat loading.* A 10-percent increase of the basic requirement is necessary for combat loading.

4. *Miscellaneous variables.* As altitude and/or temperature increase, the aircraft requirements will also increase because of a decrease in weight-lifting capability. Humidity and other weather conditions also affect the aircraft requirement. The analyst must determine the adjustments to be made because of these variables.

2-29. Airlift

This paragraph contains a nomograph (fig 2-23) which provides staff planners a rapid and accurate method for determining airlift capability, requirements, and deployment times under sustained operations.

a. *General.* Although aircraft planning factors and related data are available in various Army and Air Force manuals, these factors are neither correlated nor assembled in such manner as to permit their ready application to air transport problems that daily confront staff planners. The nomograph is designed to overcome this deficiency and to eliminate many tedious computations required to determine airlift capability and deployment time. To make full use of the nomograph, particular note

should be made of the "Explanatory Notes" therein.

b. *Functions and Factors Employed for Nomograph.*

(1) *Aircraft payload.* The payload (ACL—allowable cabin load) of a transport aircraft, in short tons, is obtained from the payload-range curve for the aircraft. Since payload reduces as the nonstop range increases, the longest nonstop distance (critical leg) of the route determines the maximum cargo payload for an entire route because effective airlift operations assume the movement of a fixed load over all legs of a route. Since unit movement requirements include primarily outsize/vehicle (bulky or low density) cargo, average ACL's are provided for both bulk (palletized or high density) and outsize cargo.

(2) *Aircraft speed.* Speed in knots (nautical miles per hour).

(3) *Ton-mile requirement.* The short tons of passengers, equipment, and supplies to be moved times the distance to be moved.

(4) *Passenger conversion factor.* 7 troops approximate 1 short ton based on a combined passenger and baggage weight of 286 pounds per individual. Use precomputed personnel short ton conversion chart (fig 2-24).

(5) *Distances.* Use table of approximate airline distances (tables 2-5 and 2-6).

c. *Conversion Factors for Other Aircraft.* The nomograph (fig 2-23) is based on C-124/C-130 aircraft data, but can be used for other transport aircraft as required. By application of the following conversion factors, a given inventory of various types of military transport aircraft can be converted to either C-124 or C-130 "equivalents" and applied to the number of aircraft scale on the nomograph.

(1) *Outsize/vehicle cargo conversion factors.*

<i>Type of aircraft</i>	<i>Conversion factor equivalents</i>	
	<i>C-124</i>	<i>C-130</i>
C-124 -----	1.00	---
C-130 -----	---	1.00
C-141 -----	2.93	2.48
C-97 -----	0.72	0.61
C-5A -----	6.22	4.37

(2) *Bulk or palletized cargo conversion factors.*

<i>Type of aircraft</i>	<i>Conversion factor equivalents</i>	
	<i>C-124</i>	<i>C-130</i>
C-124 -----	1.00	---
C-130 -----	---	1.00
C-141 -----	2.62	1.84
C-97 -----	1.09	0.77
C-135 -----	3.13	2.20
C-121 -----	1.02	0.72
C-5A -----	6.50	4.57

(3) *Application of conversion factors.* The number of C-124 or C-130 aircraft equivalents is derived by multiplying the number of given types of aircraft by applicable C-124 or C-130 factors shown above (outsize/vehicle or bulk cargo). For example, conversion of an inventory to C-124 equivalents (outsize/vehicle requirement) is as follows:

<i>Type of aircraft</i>	<i>Number ×</i>	<i>Conversion factor =</i>	<i>C-124 equivalent</i>
C-124 -----	20	1.00	20
C-141 -----	10	2.93	29
C-5A -----	4	6.22	25
Totals	34		74

AIRLIFT CAPABILITY - REQUIREMENTS - DEPLOYMENT TIMES C-124/C-130 AIRCRAFT

NOTE: Para 2-29c gives conversion factors for use with other transport aircraft.

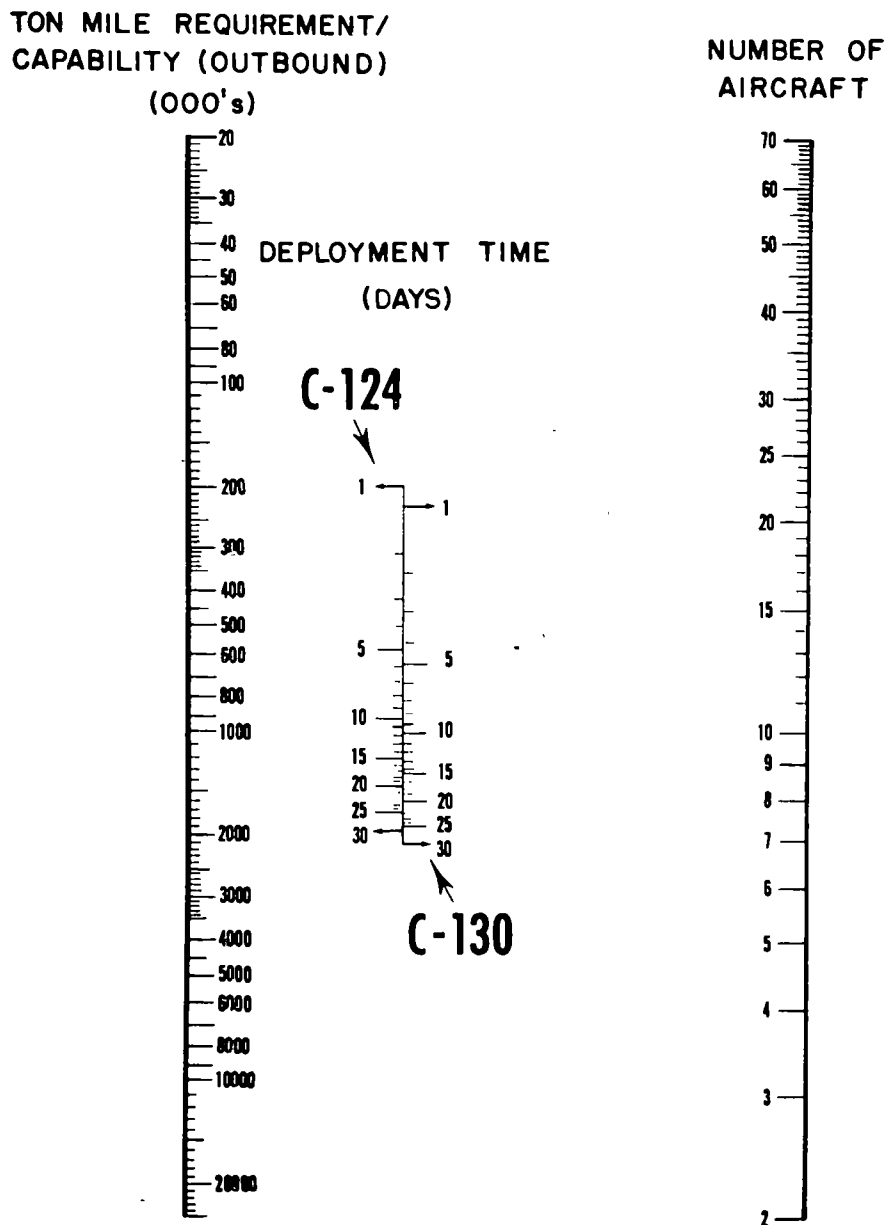


Figure 2-23. Airlift nomograph.

USES OF GRAPH

To determine:

DEPLOYMENT TIME (DAYS): If the requirement and number of aircraft are known.

TON MILE CAPABILITY (OUTBOUND): If the number of aircraft and deployment time are known.

NUMBER OF AIRCRAFT REQUIRE: If the requirement and deployment time are known.

EXAMPLES AND APPLICATION

DEPLOYMENT TIME (DAYS): Determine the time required to deploy a unit with 3330 personnel and 625 short tons (S/T) of equipment/supplies from Okinawa to Saigon (distance of 1816 nautical miles) with 50 C-124 or 50 C-130 aircraft.

Step 1 - Compute ton mile requirement (S/T x Distance). Convert personnel to S/T (fig. 2-24) 3300 pers = 476 S/T, plus 625 S/T equip/supplies = 1101 S/T requirement. 1101 total S/T requirement x 1816 miles = 1,999,400 ton mile requirement rounded off to 2,000,000. (use chart at left). Place a mark at 2000 on the ton mile requirement scale.

Step 2 - Place a mark at 50 on the Number of Aircraft scale.

Step 3 - Draw a straight line connecting the marks on both scales and the intersecting point on the Deployment Time (Days) scale of approximately $4\frac{1}{2}$ for C-124 and $3\frac{3}{4}$ for C-130 is the number of days required to deploy this unit with C-124 or C-130 aircraft.

TON MILE CAPABILITY (OUTBOUND): Determine the total ton mile capability of 25 C-124 aircraft for a nine (9) day period.

Step 1 - Place a mark at 25 on the Number of Aircraft scale.

Step 2 - Place a mark at 9 on the C-124 Deployment Time (Days) scale.

Step 3 - Draw a straight line from 25 on the Number of Aircraft scale through 9 on the C-124 Deployment Time scale and extend the line to the Ton Mile Capability scale. The reading of approximately 2,000,000 will be the total outbound ton mile capability of 25 C-124 aircraft for a none (9) day period.

NUMBER OF AIRCRAFT: Determine the number of C-130 aircraft required to deploy in four (4) days a ton mile requirement of 2,000,000.

Step 1 - Place a mark at 2000 on the Ton Mile Requirement scale.

Step 2 - Place a mark at 4 on the C-130 Deployment Time (Days) scale.

Step 3 - Draw a straight line from 2000 on the Ton Mile Requirement scale through 4 on the C-130 Deployment Time scale and extend the line to the Number of Aircraft scale. The reading of approximately 46 will be the number of C-130 aircraft required to deploy in 4 days a 2,000,000 ton mile requirement.

EXPLANATORY NOTES

1/ SCALE VALUES: Although this graph reflects specific scale values, it is applicable to higher or lower scale values by merely applying the percentage change to the answer derived from any of the given uses. Examples:

a. The time required to deploy a unit with double the requirement shown in the first example under application would be approximately 9 days for C-124 and $7\frac{1}{2}$ days for C-130 aircraft. This is obtained by applying the 100% increase in ton mile requirement (4,000,000 + 2,000,000) to the answer of $4\frac{1}{2}$ and $3\frac{3}{4}$ days for C-124 and C-130 aircraft, respectively.

b. A utilization rate of 8 hours/day (240 hours/month) was used. If a higher or lower rate is planned, the percentage change is applicable as indicated in a. above.

Figure 2-23.—Continued.

Table 2-5. Approximate Airline Distances—Pacific Area Nautical Miles

ROUTE REF NO •	Area/Airfield	—Travis US	—McChord	—Rangoon Burma	—Hong Kong China	—Shanghai	—Anderson Guam	—Hickam Hawaii
(1)	US —TRAVIS	0	578	8461(14)	7469(14)	6536(9)	5461(18)	2142
(2)	—McCHORD		0	8647(14)	7655(14)	6722(9)	5647(18)	2328
(3)	BURMA —RANGOON			0	2228(15)	2887(4)	3000(14)	6319(18)
(4)	CHINA —HONG KONG				0	659	2008(14)	5327(18)
(5)	—SHANGHAI					0	1690(13)	4394(12)
(6)	GUAM —ANDERSON						0	3319(18)
(7)	HAWAII —HICKAM							0
(8)	JOHNSTON ISLAND							
(9)	JAPAN —TACHIKAWA							
(10)	KWAJALEIN ISLAND							
(11)	KOREA —KIMPO							
(12)	MIDWAY ISLAND							
(13)	OKINAWA —KADENA							
(14)	PHILIPPINE I. —CLARK							
(15)	S. VIETNAM —SAIGON							
(16)	TAIWAN —TAIPEI							
(17)	THAILAND —BANGKOK							
(18)	WAKE ISLAND							

*Number in paren () after distances indicates airline routing.

Johnston Island	Japan —Tachikawa	Kwajalein Island	Korea —Kimpo	Midway Island	Okinawa —Kadena	Philippine I.—Clark	S. Vietnam —Saigon	Taiwan —Taipei	Thailand —Bangkok	Wake Island
2852(7)	5551(12)	4273(8)	6296(9)	3289(7)	6350(18)	6891(18)	7814(14)	6716(13)	8144(14)	4151(7)
8088(7)	5737(12)	4459(8)	6482(9)	3475(7)	6536(18)	7077(18)	8000(14)	6902(13)	8330(14)	4337(7)
5803(10)	3310(14)	4382(6)	3138(13)	5341(18)	2463(14)	1570(17)	725(17)	2200(14)	817	4310(6)
4811(10)	1718(16)	3390(6)	1615(13)	4349(18)	840(16)	678	1503	474	1911(15)	3318(6)
4127(18)	986	3386(18)	466	3247(9)	440	1001(13)	2162(4)	371	2570(15)	2750(9)
2687(18)	1386	1382	2131(9)	2841(18)	1250	1430	2353(14)	1616(13)	2683(14)	1310
710	3409(12)	2131(8)	4154(9)	1147	4280(9)	4749(6)	5672(14)	4646(13)	6002(14)	2009
0	3142(18)	1421	3887(18)	816	3576(18)	4233(6)	5156(14)	4303(13)	6486(14)	1877
	0	2401(18)	745	2262	871	1740	2663(14)	1244	2993(14)	1765
		0	8146(9)	1667(18)	2632(6)	2812(6)	3735(14)	2998(13)	4065(14)	636
			0	3007(9)	675	1568(13)	2491(14)	1041(13)	2821(14)	2510(9)
				0	3133(9)	3771(6)	4694(14)	3506(9)	5024(14)	1031
					0	898	1816(14)	366	2146(14)	2199
						0	923	630	1253	2740(6)
							0	1653(14)	408	3663(6)
								0	1883(14)	3370(6)
									0	3993(6)
										0

Table 2-6. Approximate Airline Distances—Atlantic Area Nautical Miles

AREA/AIRFIELD		CHARLESTON	DOVER	McGUIRE	BUENOS AIRES	RIO DE JANEIRO	SANTIAGO	MILDENHALL	FRANKFURT	THULE	ROBERTS FIELD	KEFLAVIK	TEHRAN	GOOSE BAY	NEWFOUNDLAND ARGENTIA	OSLO	LIMA	KINSHASA	ROTA	ADANA	JOHANNESBURG
		U.S.			ARGENTINA	BRAZIL	CHILI	ENGLAND	GERMANY	GREENLAND	GUINEA	ICELAND	IRAN	LABRADOR		NORWAY	PERU	REPUBLIC OF CONGO	SPAIN	TURKEY	SOUTH AFRICA
U.S.	Charleston	0	470	420	4500	4012	4417	3734	3955	2813	4238	2955	6726	1535	1633	4050	3099	6481	3607	5507	7000
	Dover		0	84	4970	4482	4887	3228	3505	2394	4072	2432	6391	1125	1197	3629	3570	6600	3240	5172	7200
	McGuire			0	5020	4560	4967	3184	3520	2377	4100	2350	6370	1029	1113	3549	3650	6620	3203	5151	7300

PRECOMPUTED PASSENGER: SHORT TON CONVERSION CHART

<u>Number of Passengers</u>	<u>Number of Short Tons</u>	<u>Number of Passengers</u>	<u>Number of Short Tons</u>	<u>Number of Passengers</u>	<u>Number of Short Tons</u>
7	1	252	36	497	71
14	2	259	37	504	72
21	3	266	38	511	73
28	4	273	39	518	74
35	5	280	40	525	75
42	6	287	41	532	76
49	7	294	42	539	77
56	8	301	43	546	78
63	9	308	44	553	79
70	10	315	45	560	80
77	11	322	46	567	81
84	12	329	47	574	82
91	13	336	48	581	83
98	14	343	49	588	84
105	15	350	50	595	85
112	16	357	51	602	86
119	17	364	52	609	87
126	18	371	53	616	88
133	19	378	54	623	89
140	20	385	55	630	90
147	21	392	56	637	91
154	22	399	57	644	92
161	23	406	58	651	93
168	24	413	59	658	94
175	25	420	60	665	95
182	26	427	61	672	96
189	27	434	62	679	97
196	28	441	63	686	98
203	29	448	64	693	99
210	30	455	65	700	100
217	31	462	66	798	114
224	32	469	67	903	129
231	33	476	68	1001	143
238	34	483	69	2002	286
245	35	490	70	3003	429

- NOTES:**
1. Passengers and short tons are shown in multiples of 7 and 1. For ease in computation, fractions of these multiples should be rounded off to the next highest multiple of 7 passengers or 1 short ton.
 2. Use combinations of the above conversions for number of passengers not shown.

*Figure 2-24. Precomputed personnel short ton
conversion chart.*



★CHAPTER 3

MOTOR

Section I. ORGANIZATION

3-1. Organization

Unit	TOE	Mission	Assignment	Capability
Headquarters and headquarters company transportation motor transport brigade.	55-11	To command, plan, supervise, coordinate, and control the activities of transportation highway transport groups and other assigned or attached units required in the movement of cargo or personnel by highway transport, particularly in a continuous intersectional or other line haul operation.	To a theater army command. Normally attached to the transportation command TOE 55-2.	Commanding and supervising the activities of three to seven transportation motor transport groups and supporting units.
Headquarters and headquarters detachment, transportation motor transport group.	55-12	To provide command, staff planning, and control of operations of transportation truck and/or tracked vehicle battalions.	To a transportation command or brigade. Normally attached to a motor transport brigade or may operate separately.	Commanding, planning, and supervising the activities of three to seven transportation motor transport battalions.
Headquarters and headquarters detachment transportation motor transport battalion.	55-16	To provide command and supervision of units engaged in all types of motor transport, such as direct support of tactical units, depot and terminal operations, and line hauls.	To a field army support command or theater army support command. Normally attached to a transportation motor transport group, TOE 55-12, when employed in the communications zone; to a transportation brigade, TOE 55-62; or a transportation composite group, TOE 55-52; or a support brigade TOE 54-22, when employed in the combat zone.	Provide command and supervision for three to seven of the following transportation companies or any appropriate combination thereof and attached supporting services as required. a. Transportation Light Truck Company, TOE 55-17. b. Transportation Medium Truck Company, TOE 55-18. c. Transportation Car Company, TOE 55-19. d. Transportation Cargo Carrier Company (Tracked), TOE 55-27. e. Transportation Heavy Truck Company, TOE 55-28.

Unit	TOE	Mission	Assignment	Capability
Transportation light truck company.	55-17	To provide transportation for the movement of general cargo and personnel by motor transport.	To a field army, corps, or logistical command. Normally attached to a headquarters and headquarters detachment, transportation motor, transport battalion, TOE 55-16.	<i>f.</i> Transportation Light-Medium Truck Company, TOE 55-67. Operate a truck terminal and/or trailer relay system when required. (These operations require assignment of teams from TOE 55-540 and 29-500.) At full strength, with 45 trucks available making four round trips per day in local hauls or two round trips per day (one per 10-hour shift) in line hauls, a light truck company can transport the following: <i>a.</i> When equipped with 2 ½-ton trucks: (1) For local hauls—720 short tons of cargo (4 tons per truck) based on 75-percent availability of vehicles and four trips daily on highway or 3,600 passengers (20 passengers per truck) on or off highway. (2) For line hauls—360 short tons of cargo (4 tons per truck) based on 75-percent availability of vehicles and two trips daily on highway or 1,440 passengers (16 passengers per truck) on or off highway. (3) In one lift off highway—112.5 short tons of cargo (2½ tons per truck). <i>b.</i> When equipped with 5-ton trucks: (1) Local hauls—1,080 short tons of cargo (6 tons per truck) based on 75 percent availability of vehicles and four trips daily on or off highway or 3,600 passengers (20 passengers per truck) on or off highway.

Transportation medium
truck company

55-18 To provide transportation for the movement of general cargo, bulk petroleum products, and refrigerated cargo by motor transport.

To a field army, corps, or a logistical command. Normally attached to a headquarters detachment, transportation motor transport battalion, TOE 55-16.

(2) Line hauls—540 short tons of cargo (6 tons per truck) based on 75-percent availability of vehicles and two trips daily on highway or 1,620 passengers (18 passengers per truck) on or off highway.

(3) In one lift off highway—180 short tons of cargo (4 tons per truck).

a. At full strength, with 45 semitrailer combinations available making four round trips per day in local hauls or two round trips per day (one per 10-hour shift) in line hauls, a medium truck company can transport the following:

(1) When equipped with 12-ton cargo semitrailers:

(a) Local hauls—2,160 short tons of cargo (12 tons per semitrailer) or in an emergency only, 9,000 passengers (50 passengers per semitrailer).

(b) Line hauls—1,080 short tons of cargo (12 per semitrailer) or in an emergency only, 4,500 passengers (50 passengers per semitrailer).

(2) When equipped with 5,000-gallon petroleum semitrailers:

(a) Local hauls—900,000 gallons.

(b) Line hauls—450,000 gallons.

(3) When equipped with 7½-ton refrigerator semitrailer carrying 6 tons per vehicle:

(a) Local hauls—1,080 short tons.

(b) Line hauls—540 short tons.

b. With a minor modification, i.e., military desert design tires, this unit can provide logistical and combat support in desert areas of the world.

Unit	TOE	Mission	Assignment	Capability
Transportation car company.	55-19	To transport personnel and light cargo by motor vehicle.	a. To a field army or logistical command. Normally attached to headquarters and headquarters detachment, transportation motor transport battalion, TOE 55-16; may also be assigned to independent corps force or to a corps. b. To an airborne corps.	a. Each platoon when equipped with sedans can transport 75 personnel in one lift. b. Each platoon when equipped with $\frac{1}{4}$-ton trucks and trailers can transport 45 personnel and $2\frac{1}{2}$ tons of baggage or small-sized supplies of $6\frac{1}{4}$ tons of small-sized supplies and cargo, mail, or light commodities in one lift. c. Each platoon when equipped with $\frac{3}{4}$-ton trucks can transport $11\frac{1}{4}$ tons of cargo or 120 people in one lift. d. Each composite platoon composed of ten $\frac{1}{4}$-ton trucks and trailers and ten $\frac{3}{4}$-ton trucks (designated the airborne platoons in the airborne organization) is capable of transporting 82 personnel and $7\frac{1}{2}$ tons of baggage or small-sized supplies or 10 tons of small-sized supplies and cargo, mail, or light commodities in one lift. e. All capabilities are computed on a 75-percent availability of vehicles and all vehicles carrying rated capacity. f. When organized for assignment to an airborne corps, the parachute platoon has the capability of being landed by parachute or aircraft. All personnel in this platoon are airborne qualified.
Transportation cargo carrier company (tracked).	55-27	To provide transportation for supply distribution in regions where wheeled vehicles cannot operate effectively.	To a division employed in regions where wheeled vehicles cannot operate effectively. To a corps, field army, or logistical command, as required.	At full strength (level 1) this unit is capable of the following: a. With all vehicles available, transporting in one lift 288 short tons of cargo. b. In sustained operations, based on 75-percent vehicle availability, transporting 216 short tons of cargo or

				when equipped with tank units, transporting 43,200 gallons of fuel 50 miles forward daily.															
Transportation heavy truck company.	55-28	To provide truck transportation for the movement of tanks and other heavy or bulky vehicles and to transport heavy, bulky, and outsized cargo.	To a field army, corps, or a logistical command.	At full strength, operating two 10-hour shifts per day, with 18 tractor trucks and semitrailers available, this unit can: a. For local hauls-transport 2,880 short tons of cargo, or tanks, or similar vehicles, avraging 40 tons per truck, four round trips daily. b. For line hauls—transport 1,440 short tons of cargo or tanks or similar vehicles, averaging 40 tons per truck, two round trips daily.															
Transportation light—medium truck company.	55-67	To provide transportation for the movement of general cargo and personnel by motor transport.	To a field army support command, corps support brigade, or a logistical command. Normally attached to a supply and service battalion, transportation general support battalion, or transport battalion (DS).	<table><thead><tr><th></th><th>Cargo</th><th>Personnel</th></tr></thead><tbody><tr><td>a. At full strength, all vehicles available, one-time lift -----</td><td>360</td><td>1,700</td></tr><tr><td>b. At full strength, 75 percent of vehicles available, one-time lift -----</td><td>276</td><td>1,300</td></tr><tr><td>c. Local haul, 15 miles forward, two-shift operations, 75 to 80 percent of vehicles available, four trips cargo and six trips personnel -----</td><td>1,104</td><td>7,800</td></tr><tr><td>d. Line haul, 75 miles forward, two-shift operations, 75 to 80 percent of vehicles available, two trips daily ---</td><td>552</td><td>2,600</td></tr></tbody></table>		Cargo	Personnel	a. At full strength, all vehicles available, one-time lift -----	360	1,700	b. At full strength, 75 percent of vehicles available, one-time lift -----	276	1,300	c. Local haul, 15 miles forward, two-shift operations, 75 to 80 percent of vehicles available, four trips cargo and six trips personnel -----	1,104	7,800	d. Line haul, 75 miles forward, two-shift operations, 75 to 80 percent of vehicles available, two trips daily ---	552	2,600
	Cargo	Personnel																	
a. At full strength, all vehicles available, one-time lift -----	360	1,700																	
b. At full strength, 75 percent of vehicles available, one-time lift -----	276	1,300																	
c. Local haul, 15 miles forward, two-shift operations, 75 to 80 percent of vehicles available, four trips cargo and six trips personnel -----	1,104	7,800																	
d. Line haul, 75 miles forward, two-shift operations, 75 to 80 percent of vehicles available, two trips daily ---	552	2,600																	
Transportation motor transport company, supply and transport battalion, infantry division (mechanized).	55-84	a. To provide transportation for unit distribution of all classes of supply except class V. b. To transport division reserve supplies for which the unit is re-	Organic to supply and transport battalion infantry division (mechanized) TOE 29-65.	At level 1, this unit has, based on 75-percent vehicle availability, a capability of transporting:															

Unit	TOE	Mission	Assignment	Capability									
		sponsible.		<table><tr><td></td><td>Single lift</td><td>Shuttle</td></tr><tr><td>Cargo, short tons --</td><td>270</td><td>342</td></tr><tr><td>POL, gallons -----</td><td>95,700</td><td>104,550</td></tr></table>		Single lift	Shuttle	Cargo, short tons --	270	342	POL, gallons -----	95,700	104,550
	Single lift	Shuttle											
Cargo, short tons --	270	342											
POL, gallons -----	95,700	104,550											
Transportation motor transport company, supply and transport battalion, armored division.	55-87	a. To furnish vehicles required for displacing division headquarters and division administration company and to supplement transport means available to other elements of the division. b. To provide transportation for unit distribution of all classes of supply except class V. c. To transport the division reserve supplies for which the unit is responsible. d. To furnish vehicles required for displacing division headquarters and the division administration company and to supplement means available to other elements of the division.	Organic to supply and transport battalion, armored division, TOE 29-115.	At level 1, this unit, based on 75-percent vehicle availability, has a capability of transporting: <table><tr><td></td><td>Single lift</td><td>Shuttle</td></tr><tr><td>Cargo, short tons --</td><td>270</td><td>360</td></tr><tr><td>POL, gallons -----</td><td>119,550</td><td>119,550</td></tr></table>		Single lift	Shuttle	Cargo, short tons --	270	360	POL, gallons -----	119,550	119,550
	Single lift	Shuttle											
Cargo, short tons --	270	360											
POL, gallons -----	119,550	119,550											
Transportation motor transport company supply and transport battalion infantry division.	55-88	a. To furnish vehicles required for displacing division headquarters and the division administration company and to supplement means available to other elements of the division. b. To provide transportation for unit distribution of all classes of supply except class V. c. To transport the division reserve supplies for which the unit is responsible. d. To furnish vehicles required for displacing division headquarters and the division administration company and to supplement means available to other elements of the division.	Organic to supply and transport battalion, armored division, TOE 29-5.	At level 1, this unit, based on 75-percent vehicle availability, has a capacity of transporting: <table><tr><td></td><td>Single lift</td><td>Shuttle</td></tr><tr><td>Cargo, short tons --</td><td>270</td><td>120</td></tr><tr><td>POL, gallons -----</td><td>74,250</td><td>74,250</td></tr></table>		Single lift	Shuttle	Cargo, short tons --	270	120	POL, gallons -----	74,250	74,250
	Single lift	Shuttle											
Cargo, short tons --	270	120											
POL, gallons -----	74,250	74,250											
Transportation motor transport company, supply and transport battalion, airborne division.	55-97	To provide transportation for unit distribution of all classes of supply except class V.	Organic to supply and transport battalion, airborne division, TOE 29-45.	a. At full strength, based on 75-percent availability, transports in one lift: (1) 108 short tons of general cargo. (2) 3,600 gallons of POL. b. At full strength, this unit is cap-									

Team GA, car squad	55-540	To transport passengers, messengers, and a limited amount of cargo by sedans, ¼-ton utility truck, or ¾-ton cargo truck.	To a theater army or field support command. Normally attached to a headquarters and headquarters detachment, transportation motor transport battalion, TOE 55-16, or may operate separately under the supervision of the appropriate staff movements officer.	able of providing transportation for two 10-hour shifts during a round-the-clock operation. (1) When equipped with sedans, transporting 40 passengers per lift, eight sedans available. (2) When equipped with ¼-ton utility trucks, transporting 24 passengers and 2-tons of cargo (¼-ton per trailer) per lift based upon eight available ¼-ton utility trucks. (3) When equipped with ¾-ton cargo trucks, transporting six passengers or 12 tons of cargo (¾-ton per truck and trailer) per lift based upon eight available ¾-ton trucks.
Team GB, bus squad	55-540	To transport personnel or litter patients by bus.	To a theater army or field army support command. Normally attached to a headquarters and headquarters detachment, transportation motor transport battalion TOE 55-16, or may operate separately under the supervision of the appropriate staff movements officer.	Transporting 185 passengers (five available buses carrying 37 passengers each) or 90 litter patients (five available buses carrying 18 litter patients each) per lift in local haul.
Team GC, heavy truck squad	55-540	To transport general and outsized or heavy lift cargo by heavy truck tractor-semitrailer combinations.	To a theater army or field army support command. Normally, attached to a motor transport company or may operate separately under supervision of the appropriate staff movements officer.	Transporting 300 short tons per lift in local or line haul based upon 50 tons per each of six available truck tractor-semi-trailer combinations.
Team GD, light truck squad	55-540	To transport personnel or cargo by light truck.	To a theater army or field army support command. Normally, attached to a motor transport company or may operate separately under supervision of the appropriate staff movements officer.	(1) When equipped with a 2½-ton cargo truck, transporting 32 tons of cargo or 160 passengers per lift based upon eight available trucks and eight available 1½-ton cargo trailers. (2) When equipped with 5-ton cargo trucks, transporting 52 tons of

Unit	TOE	Mission	Assignment	Capability
Team GE, medium truck squad	55-540	To transport general cargo bulk petroleum products, or refrigerated cargo by medium truck tractor-semitrailer combinations.	To a theater army or field army support command. Normally, attached to a motor transport company or may operate separately under supervision of the appropriate staff movements officer.	cargo or 176 passengers per lift based upon eight available trucks and eight available 1½-ton cargo trailers. (1) When equipped with 12-ton stake and platform semitrailers, the squad can transport 96 tons of cargo per lift based upon eight available semitrailer-tractor combinations, each carrying 12 tons. (2) When equipped with 5,000-gallon petroleum semitrailers, the squad can transport 40,000 gallons of bulk petroleum products per lift based upon eight available semitrailer-tractor combinations, each carrying 5,000 gallons. (3) When equipped with 7½-ton refrigerator semitrailers, the squad can transport 60-tons of refrigerated cargo in one lift, based upon eight available semitrailer-tractor combinations, each carrying 7.5 tons of cargo.
Team GF, trailer transfer point operations team	55-540	To operate a trailer transfer point marshaling yard or truck terminal in conjunction with line haul operations.	To a transportation motor transport group responsible for line of communications (LOC) motor transport operations.	Operates in conjunction with a line haul operation, a trailer transfer point with a maximum capacity of 250 12-ton trailer units in and out per day. The operation includes receiving, segregating, and assembling loaded or empty semitrailers for convoys; maintaining POL dispersing facilities to refuel hauling equipment; and servicing, inspecting, and if required, making emergency repairs to incoming vehicles.
Team GG, highway regulating point team	55-540	To operate a highway regulating point to coordinate the movement of authorized traffic and to effect changes in truck or convoy routings.	To a theater army or field army support command. Normally attached to a headquarters and headquarters detachment, transportation movement control agency or company.	Performs the following on a 24-hour per day basis: (1) Reports on convoy and other elements arriving at and clearing the point so that progress may be re-

ported and recorded; adjusts their rate of advance as required.

(2) Receives, correlates, and disseminates information of forecasted or passing traffic; makes reports on current highway conditions and changes as they occur.

(3) Transmits orders from higher headquarters to passing units or organizations and makes diversions and effects changes in priorities of traffic as directed by the appropriate traffic headquarters or comparable unit.

(4) Receives and passes to appropriate agency requests for road clearance; checks clearance of passing units.

Section II. VEHICLE CHARACTERISTICS

3-2. Performance Data

Nomenclature	Payload (lb)		Maximum grade (percent)		Maximum allowable speed (mph)	Cruising range (miles)	Towed load allowance (lb)	Fording depth (in.)		
	cross-country	highway	w/towed load	wo/towed load				cross-country	highway	w/o sp equip
Truck, utility, ¼-ton, 4×4, M38A1	800	1,200	69	--	55	280	1,500		2,000	36
Truck, utility, ¼-ton, 4×4, M151	800	1,200	60	--	66	300	1,500		2,000	21
Truck, utility, ¼-ton, 4×4, M151A1	800	1,200	75	--	65	300	1,500		2,000	21
Truck, cargo, ¾-ton, 4×4, M37	1,500	2,000	67	68	55	225	4,000		6,000	42
Truck, cargo, 2½-ton, 6×6, M34	5,000	10,000	48	64	62	300	6,000		10,000	31
Truck, cargo, 2½-ton, 6×6, M35	5,000	10,000	46	63	58	300	6,000		10,000	30

Nomenclature	Payload (lb)		Maximum grade (percent)		Maximum allowable speed (mph)	Cruising range (miles)	Towed load allowance (lb)		Fording depth (in.)	
	cross-country	highway	w/towed load	wo/towed load			cross-country	highway	w/ sp equip	w/sp equip
Truck, cargo, 2½-ton, 6×6, M35A1	5,000	10,000	45	60	56	320	6,000	10,000	30	72
Truck, cargo, 2½-ton, 6×6, M35A2	5,000	10,000	45	60	56	275	6,000	10,000	30	72
Truck, cargo, drop side, 2½-ton, 6×6, M35A2C	5,000	10,000	45	60	56	275	6,000	10,000	30	72
Truck, cargo, 2½-ton, 6×6, M36A1	5,000	10,000	45	60	56	320	6,000	10,000	30	72
Truck, cargo, 2½-ton, 6×6, M36A2	5,000	10,000	45	60	56	320	6,000	10,000	30	72
Truck, cargo, 2½-ton, 6×6, M36C	5,000	10,000	45	63	58	300	6,000	10,000	30	72
Truck, tank, fuel, servicing, 1,200-gal., 2½-ton, M49A1C	600-gal.	1,200-gal.	45	60	56	320	6,000	10,000	40	72
Truck, gasoline, tank, 2½-ton, M49	5,000	7,500	47	62	58	300	6,000	10,000	40	72
Truck, tank, water, 2½-ton, 6×6, M50	5,000	8,300	47	63	58	300	6,000	10,000	30	78
Truck, tank, water, 1000-gal., 2½-ton, 6×6, M50A1	400-gal.	1,000-gal.	45	60	56	320	6,000	10,000	40	72
Truck, dump, 2½-ton, 6×6, M59	5,000	10,000	47	62	62	300	3,750	9,000	40	72
Truck, dump, 5-ton, 6×6, M51A2	10,000	20,000	--	62	54	447	15,000	30,000	30	78
Truck, tractor, 5-ton, 6×6, M52	15,000	25,000	28	68	53	300	37,500	55,000	30	78
Truck, cargo, 5-ton, 6×6, M54	10,000	20,000	51	74	53	214	15,000	30,000	70	78
Truck, cargo, 5-ton, 6×6, M54A2	10,000	20,000	47	60	54	350	15,000	30,000	30	78
Truck, cargo, 5-ton, 6×6, drop side, M54A2C	10,000	20,000	47	60	54	350	15,000	30,000	30	78

Truck, cargo, 5-ton, 6×6, M55A2	10,000	20,000	47	60	54	350	15,000	30,000	30	78
Truck, medium wrecker, 5-ton, M62	7,000	12,000	36	58	53	214	20,000	30,000	30	78
Truck, van, expansible, 5-ton, 6×6, M291A2C	5,000	15,000	--	60	58	---	15,000	30,000	--	--

3-3. Axle Weights

Nomenclature	Front axle w/winch	Rear axles w/winch	Curb weight (1b)		Rear axles wo/winch	Total	Front axle w/winch	Gross weight, payload and personnel (1b)		Front axle wo/winch	Rear axles wo/winch	Total
			Total	Front axle wo/winch				Rear axles w/winch	Total			
Truck, cargo, 2½-ton, 6×6, M34	5,900	6,286	12,186	5,405	6,370	11,775	6,325	11,211	17,536	5,830	11,295	17,125
Truck, cargo, 2½-ton, 6×6, M35	5,810	7,070	12,880	5,315	7,150	12,465	6,256	11,974	18,230	5,761	12,054	17,815
Truck, cargo, 2½-ton, 6×6, M35A1	6,580	7,320	13,900	5,980	7,420	13,400	7,472	16,828	24,300	6,976	16,824	23,800
Truck, cargo, 2½-ton, 6×6, M35A2	6,580	7,320	13,900	5,980	7,420	13,400	7,472	16,828	24,300	6,976	16,824	23,800
Truck, cargo, drop side, 2½-ton, M35A2C	6,630	7,530	14,160	6,030	7,630	13,660	7,626	16,934	24,560	7,026	17,034	24,060
Truck, cargo, 2½-ton, 6×6, M36A1	6,580	8,260	15,110	6,250	8,360	14,610	7,700	17,810	25,510	7,100	17,910	25,010
Truck, cargo, 2½-ton, 6×6, M36A2	6,850	8,260	15,110	6,250	8,360	14,610	7,700	17,810	25,510	7,100	17,910	25,010
Truck, cargo, 2½-ton, 6×6, M36C	6,140	9,100	15,240	5,640	9,190	14,830	6,751	13,839	20,590	6,149	14,031	20,180
Truck, tank, fuel servicing 1,200-gal., 2½-ton, 6×6, M49A1C	6,495	8,630	15,125	5,895	8,730	14,625	7,205	17,320	24,525	6,605	17,420	24,025
Truck, gasoline tank, 2½-ton, 6×6, M49	5,745	8,150	13,895	5,250	8,240	13,490	6,079	13,166	19,245	5,545	13,295	18,840
Truck, tank, fuel servicing, 1,200-gal., 2½-ton, 6×6, M49A2C	6,495	8,630	15,125	5,895	8,730	14,625	7,205	17,320	24,525	6,605	17,420	24,025

Nomenclature	Front axle w/winch	Rear axles w/winch	Curb weight (lb)		Rear axles wo/winch	Total	Front axle w/winch	Gross weight, payload and personnel (lb)			Front axle wo/winch	Rear axles wo/winch	Total
			Total	Front axle wo/winch				Rear axles w/winch	Total				
Truck, tank, water, 2½-ton, 6×6, M50	----	----	-----	5,405	9,779	15,184	----	-----	-----		5,715	14,819	20,534
Truck, tank, water, 1,000-gal., 2½-ton, 6×6, M50A1	6,550	8,070	14,620	5,950	8,170	14,120	7,370	15,650	23,020		6,770	15,750	22,520
Truck, tank, water, 1,000-gal., 2½-ton, 6×6, M50A2	6,550	8,070	14,620	5,950	8,170	14,120	7,370	15,650	23,020		6,770	15,750	22,520
Truck, dump, 2½-ton, 6×6, M59	5,950	8,510	14,460	5,420	8,630	14,050	6,220	13,590	19,810		5,680	13,710	19,400
Truck, light, wrecker, 2½-ton, 6×6, M60	----	----	-----	6,880	17,080	23,960	----	-----	-----		7,246	20,567	27,810
Truck, van, shop, 2½-ton, M109	----	----	-----	5,485	9,746	15,231	----	-----	-----		5,855	14,726	20,581
Truck, van, shop, 2½- ton, 6×6, M109A2	6,550	8,980	15,530	5,950	9,080	15,030	7,110	16,320	23,430		6,510	16,420	22,930
Truck, van, shop, 2½- ton, 6×6, M109A3	6,550	8,980	15,530	5,950	9,080	15,030	7,110	16,320	23,430		6,510	16,420	22,930
Truck, cargo, 2½-ton, 6×6, M135	5,580	6,920	12,500	5,150	6,850	12,000	6,010	11,840	17,850		5,580	11,770	17,350
Truck, repair shop van, 2½-ton, 6×6, M185A3	----	----	-----	5,980	10,820	16,800	----	-----	-----		6,290	15,910	22,900
Truck, cargo, 2½-ton, 6×6, M211	5,740	7,840	13,580	5,300	7,870	13,170	6,070	12,870	18,930		5,630	12,890	18,520
Truck, dump, 2½-ton, 6×5	5,790	9,080	14,870	5,320	9,140	14,460	6,030	12,940	18,970		5,566	13,000	18,560
Truck, gasoline tank, 2½-ton, M217	----	----	-----	5,330	9,010	14,340	----	-----	-----		5,970	13,720	19,690
Truck, gasoline tank, 2½-ton, M217C	----	----	-----	5,330	9,010	14,340	----	-----	-----		5,970	13,720	19,690
Truck, van shop, 2½- ton, M220	----	----	-----	5,305	9,780	15,085	----	-----	-----		5,695	14,740	20,435
Truck, water tank, 2½-ton, 6×6, M222	----	----	-----	5,595	10,898	15,693	----	-----	-----		6,121	13,422	19,543

Truck, van, expan- sible, 2½-ton, M292	----	----	-----	7,495	13,114	20,609	----	-----	-----	8,085	17,874	25,959
Truck, van, expan- sible, 2½-ton, 6×6, M292A2	----	----	-----	8,045	13,164	21,209	----	-----	-----	8,635	17,974	26,609
Truck, van, expan- sible, 2½-ton, 6×6, M292A5	----	----	-----	7,520	15,409	22,929	----	-----	-----	8,110	20,219	28,329
Truck, cargo, 2-½- ton, 6×6, M602	5,915	7,050	12,965	5,315	7,150	12,465	6,909	16,456	23,365	6,309	16,556	22,865
Truck, van, shop, 2½-ton, 6×6, M609A1	6,085	9,646	15,731	5,455	9,746	15,201	6,645	16,886	23,531	6,015	16,986	23,101
Truck, tank water, 1,000-gal., 2½-ton, 6×6, M610	----	----	-----	5,400	8,120	13,520	----	-----	-----	6,220	15,700	21,920
Truck, tank gasoline, 1,200-gal., 2½-ton, 6×6, M611	----	----	-----	5,345	8,680	14,025	----	-----	-----	6,055	17,370	23,425
Truck, tank, fuel servicing, 1,200-gal., 2½-ton, 6×6, M611C	----	----	-----	5,345	8,680	14,025	----	-----	-----	6,055	17,370	23,425
Truck, van, shop, 2½- ton, 6×6, M613	6,030	10,670	16,700	5,430	10,770	16,200	6,340	15,760	22,100	5,740	15,860	26,600
Truck, dump, 2½-ton, 6×6, M614	6,305	9,360	15,665	5,705	9,460	15,165	7,211	18,854	25,565	6,611	18,954	25,565
Truck, cargo, 2½-ton, 6×6, M621	6,692	6,752	13,444	6,092	6,852	12,944	7,688	16,156	23,844	7,088	16,256	23,344
Truck, tank, fuel, servicing, 1,200-gal., 2½-ton, 6×6, M622	----	----	-----	6,007	8,162	14,169	----	-----	-----	6,717	16,852	23,596
Truck, van, shop, 2½-ton, 6×6, M623	----	----	-----	6,062	8,512	14,574	----	-----	-----	6,622	15,852	22,474
Truck, dump, 2½-ton, 6×6, M624	----	----	-----	6,239	9,476	15,715	----	-----	-----	7,145	18,970	-----
Truck, cargo, 5-ton, 6×6, M41	9,185	10,650	19,835	8,330	10,790	19,120	9,665	20,520	30,185	2,810	20,660	29,470

Nomenclature	Front axle w/winch	Rear axles w/winch	Curb weight (1b)			Gross weight, payload and personnel (1b)						
			Total	Front axle wo/winch	Rear axles wo/winch	Total	Front axle w/winch	Rear axles w/winch	Total	Front axle wo/winch	Rear axles wo/winch	Total
Truck, dump, 5-ton, 6×6, M51	9,305	13,360	22,360	8,460	13,520	21,980	9,503	26,160	32,663	8,658	23,322	31,980
Truck, dump, 5-ton, 6×6, M51A2	9,150	13,550	22,700	8,260	13,660	21,920	9,610	33,490	43,100	8,720	33,600	42,320
Truck, tractor, 5-ton, 6×6, M52	9,008	9,988	18,996	8,163	10,150	18,312	9,384	24,612	33,996	8,539	24,774	33,313
Truck, tractor, 5-ton, 6×6, M52A2	8,800	9,900	18,700	7,810	10,030	17,840	9,430	34,270	43,700	8,440	34,400	42,840
Truck, cargo, 5-ton, 6×6, M54	8,735	11,210	19,945	7,884	11,347	19,231	9,404	20,891	30,295	8,553	21,028	29,581
Truck, cargo, 5-ton, 6×6, M54A2	8,700	11,700	20,400	7,720	11,820	19,540	9,930	30,870	40,800	8,950	30,990	39,940
Truck, cargo, drop sides, 5-ton, 6×6, M54A2C	8,720	11,940	20,660	7,740	12,060	19,800	9,890	31,170	41,060	8,910	31,290	40,200
Truck, cargo, 5-ton, 6×6, M55	8,998	15,066	24,064	8,147	15,202	23,349	9,178	24,886	34,064	-----	-----	-----
Truck, cargo, 5-ton, 6×6, M55A2	8,440	15,060	23,900	7,880	15,160	23,040	9,450	34,850	44,300	8,490	34,950	43,440
Truck, medium, wrecker, 5-ton, 6×6, M62	9,325	24,000	33,325	-----	-----	-----	5,027	35,298	40,325	-----	-----	-----
Truck, tractor-wreck- er, 5-ton, 6×6, M246	12,785	20,045	32,830	-----	-----	-----	13,026	36,154	49,180	-----	-----	-----
Truck, van, expan- sible, 5-ton, 6×6, M291A2	-----	-----	-----	9,000	17,100	26,100	-----	-----	-----	9,960	31,540	41,500
Truck, van, expan- sible, 5-ton, 6×6, M291A2C	-----	-----	-----	8,900	16,900	25,800	-----	-----	-----	9,860	31,340	41,200
Truck, wrecker, medium, 5-ton, 6×6, M543A2	9,300	25,100	34,400	-----	-----	-----	-----	-----	-----	-----	-----	-----
Semitrailer stake, 6- ton, 2W, M118A1	-----	-----	-----	-----	4,750	7,100	-----	-----	-----	-----	15,030	25,100

Semitrailer, van, 6-ton, 2W, M119	----	----	-----	----	4,925	7,180	----	-----	-----	----	14,160	23,380
Semitrailer, van, shop, 6-ton, 2W, M146	----	----	-----	----	4,880	6,950	----	-----	-----	----	11,880	18,950
Semitrailer, van, shop, folding sides 6-ton, 4W, M447	----	----	-----	----	10,900	15,175	----	-----	-----	----	16,415	23,120
Semitrailer, van, shop, closed sides, rear doors, 6-ton, 2W, M508	----	----	-----	----	4,925	7,180	----	-----	-----	----	14,160	23,380
Semitrailer, van, shop, double side doors, 6-ton, 2W, M508C	----	----	-----	----	4,925	7,180	----	-----	-----	----	14,160	23,380
Semitrailer, tank, fuel 4W, 5,000-gal., M131A4	----	----	-----	----	9,470	12,900	----	-----	-----	----	29,520	48,150
Semitrailer, refrigerator, 7½-ton, 2W, M349A1	----	----	-----	----	4,940	8,600	----	-----	-----	----	13,960	23,600
Semitrailer, cargo, 12-ton, 4W, M127	----	----	-----	----	9,950	14,240	----	-----	-----	----	30,200	50,240
Semitrailer, van, cargo, 12-ton, 4W, M128A1C	----	----	-----	----	10,800	15,600	----	-----	-----	----	31,300	51,600
Semitrailer, van, supply, 12-ton, 4W M129A1C	----	----	-----	----	10,800	15,600	----	-----	-----	----	31,300	51,600
Semitrailer, low bed, wrecker, 12-ton, 25-ft load deck, M269A1	----	----	-----	----	10,520	14,200	----	-----	-----	----	36,000	54,200
Semitrailer, refrigerator, 15-ton, 4W, M347	----	----	-----	----	10,650	16,350	----	-----	-----	----	30,000	46,000
Semitrailer, low bed, 25-ton, 4W, M172	----	----	-----	----	10,850	15,500	----	-----	-----	----	40,850	65,500

Nomenclature	Front axle w/winch	Rear axles w/winch	Curb weight (1b)		Rear axles wo/winch	Total	Front axle w/winch	Gross weight, payload and personnel (1b)		Front axle wo/winch	Rear axles wo/winch	Total
			Total	Front axle wo/winch				Rear axles w/winch	Total			
Semitrailer, tank transporter, 50-ton, 8W, M15A2	----	----	-----	----	28,520	41,790	----	-----	-----	----	81,890	141,790
Semitrailer, gasoline tank, 5,000-gal., 4W, M131	----	----	-----	----	11,530	14,850	----	-----	-----	----	27,910	45,390
Semitrailer, gasoline tank, 5,000-gal., 4W, M131A2	----	----	-----	----	8,900	12,400	----	-----	-----	----	26,200	42,900
Semitrailer, tank, fuel servicing, 5,000-gal., 4W, M131A4	----	----	-----	----	9,470	12,900	----	-----	-----	----	29,520	48,150
Semitrailer, tank, fuel servicing, 5,000-gal., 4W, M131A4C	----	----	-----	----	10,150	13,850	----	-----	-----	----	30,200	49,100
Semitrailer, tank, fuel servicing, 5,000-gal., 4W, M131A5D	----	----	-----	----	10,450	14,200	----	-----	-----	----	30,500	48,200

3-4. Center of Gravity Location

	Curb weight				With payload evenly distributed			
	with winch		without winch		with winch		without winch	
	above ground (in.)	rear of centerline of front axle (in.)	above ground (in.)	rear of centerline of front axle (in.)	above ground (in.)	rear of centerline of front axle (in.)	above ground (in.)	rear of centerline of front axle (in.)
Truck, cargo, $\frac{3}{4}$ -ton, 4×4, M37	28	51	28	53	34	63	34	65
Truck, ambulance, $\frac{3}{4}$ - ton, 4×4, M43E2	--	--	32	60	--	--	35	68
Truck, cargo, $1\frac{1}{4}$ -ton, 4×4, M715	31	56.6	31	60.7	32	80.4	32	84.4
Truck, ambulance, $1\frac{1}{4}$ -ton, 4×4, M725	--	--	39	71	--	--	42	84
Truck, cargo, $2\frac{1}{2}$ -ton, 6×6, M35A2	38	81	38	85.5	46	110	46.5	113
Truck, cargo, drop side, $2\frac{1}{2}$ -ton, 6×6, M35A2C	38	81	38	85.5	46	110	46.5	113
Truck, cargo, $2\frac{1}{2}$ -ton, 6×6, M36A1	39.5	84	40	88	46.5	104	47	111
Truck, cargo, $2\frac{1}{2}$ -ton, 6×6, M36C	34.7	95	34.3	98.5	43	110	42.6	113.5
Truck, tank, fuel, ser- vicing, 1,200-gal., $2\frac{1}{2}$ -ton, M49A1C	--	--	41	92	--	--	50	113
Truck, gasoline tank, $2\frac{1}{2}$ -ton, 6×6, M49	41.1	90.2	41	94	49.8	105.8	50	109
Truck, water, tank, $2\frac{1}{2}$ -ton, 6×6, M50A2	41	85	41	89	50	105	50	109
Truck, light, wrecker, $2\frac{1}{2}$ -ton, 6×6, M60	42	110	--	--	49	114	--	--
Truck, van, shop, $2\frac{1}{2}$ - ton, 6×6, M109A3	46	89	46.5	93	59	108	59.5	111
Truck, cargo, $2\frac{1}{2}$ -ton, 6×6, M135	38	85	38	88	48	102	48	105
Truck, repair shop van, $2\frac{1}{2}$ -ton, 6×6, M185A3	--	--	48	99	--	--	56.6	115.5
Truck, cargo, $2\frac{1}{2}$ -ton, 6×6, M211	37	89	37	89	49	106	49	106
Truck, dump, $2\frac{1}{2}$ -ton, 6×6, M215	36	89	36	92	45	108	45	110
Truck, water tank, $2\frac{1}{2}$ -ton, 6×6, M222	--	--	37	94	--	--	48	113
Truck, tractor, $2\frac{1}{2}$ - ton, 6×6, M275A2	38	66	38	70	--	--	--	--
Truck, van, expansi- ble, $2\frac{1}{2}$ -ton, 6×6, M292A5	--	--	58	125	--	--	65	143
Truck, dump, $2\frac{1}{2}$ -ton, 6×6, M342A2	42	89	42	93	50	110	50	113
Truck, cargo, $2\frac{1}{2}$ -ton, 6×6, M602	38	84	37.5	88	48	109.5	48	112.5

	Curb weight				With payload evenly distributed			
	with winch above ground (in.)	rear of centerline of front axle (in.)	without winch above ground (in.)	rear of centerline of front axle (in.)	with winch above ground (in.)	rear of centerline of front axle (in.)	without winch above ground (in.)	rear of centerline of front axle (in.)
Truck, tractor, 2½-ton, 6×6, M607	--	--	38	70	--	--	105	105
Truck, van, shop, 2½-ton, 6×6, M609A1	45.5	94.5	46	98.5	52	113	52	114
Truck, tank water, 1,000-gal., 2½-ton, 6×6	--	--	41	89	--	--	50	109
Truck, tank, fuel servicing 1,200-gal., 2½-ton, 6×6, M611C	--	--	41	92	--	--	50	113
Truck, van, shop, 2½-ton, 6×6, M613	47	95	48	99	56.5	114.5	56.5	115.5
Truck, dump, 2½-ton, 6×6, M614	42	92	42	96	49	112	49	115

3-5. Stowage Capacity of Cargo Truck Bodies

Vehicle	Cargo body stowage capacities (cu ft)*		
	Under bows	Top of side racks	Top of steering wheel
¾-ton capacity			
M37 -----	134.9 ^{abc}	84.3 ^{ac}	66.7 ^{ac}
M37B1 -----	146.1 ^{ab}	95.7 ^a	78.0 ^a
1¼-ton capacity			
M561 -----	235.0 ^{de}	152.4 ^d	130.1 ^{df}
M715 -----	186.6 ^{gh}	131.4 ^g	82.2 ^g
2½-ton capacity			
M34 -----	389.0 ^{ijk}		245.9 ⁱ
M35 -----	442.6 ^j	273.2	215.6
M35A1 -----	442.6 ^j	273.2	215.6
M35A2 -----	442.6 ^j	273.2	215.6
M35A2C -----	442.6 ^j	273.2	215.6
M36 -----	761.5 ^l	385.0	318.7
M36A2 -----	761.5 ^l	385.0	318.7
M135 -----	391.0 ^{mj}	337.7 ^m	229.5 ^m
M211 -----	442.6 ^j	273.2	194.6
5-ton capacity			
M41 -----	446.2 ^{nopk}		275.0 ^{no}
M54 -----	494.8 ^{qr}	289.7 ^q	225.5 ^q
M54A2 -----	494.8 ^{qr}	289.7 ^q	225.5 ^q
M55 -----	751.5 ^s	453.5	350.1
M55A2 -----	751.5 ^s	453.5	350.1
M656 -----	539.9 ^r	227.9	^t
10-ton capacity			
M125 -----	590.6 ^{uv}	398.1 ^u	216.0 ^u
M125A1 -----	590.6 ^{uv}	398.1 ^u	216.0 ^u

*See footnotes at end of paragraph 3-7.

3-6. Stowage Capacity of Dump Truck Bodies

Vehicle	Cargo body loading capacities (cu ft)*		
	Top of body sides	Top of side racks	Top of cab shield
2½-ton capacity			
M47 -----	^k	118.1	212.2
M59 -----	^k	115.9	214.4
M215 -----	^k	115.9	245.0
M34A2 -----	^k	138.6	266.5
5-ton capacity			
M51 -----	^k	157.6	297.6
M51A2 -----	^k	157.6	297.6

3-7. Stowage Capacity of Cargo Trailer Bodies

Vehicle	Cargo body loading capacities (cu ft)		
	Under bows	Top of side racks	Top of side panel
¾-ton capacity			
M100 -----	None	None	29.7 ^w
M416 -----	None	None	31.8 ^w
¾-ton capacity			
M101 -----	170.5 ^x	114.7 ^x	60.9 ^x
M101A1 -----	170.5 ^x	114.7 ^x	60.9 ^x
1½-ton capacity			
M104 -----	273.2 ^{yz}	207.8 ^y	79.1 ^y
M104A1 -----	273.2 ^{yz}	207.8 ^y	79.1 ^y
M105 -----	276.6 ^{yz}	206.0 ^y	79.0 ^y
M105A1 -----	276.6 ^{yz}	206.0 ^y	79.0 ^y
M105A2 -----	276.6 ^{yz}	206.0 ^y	79.0 ^y

^a Cubic capacity reduced 6.6 cubic feet for wheel wells.

^b Cubic capacity reduced 3.3 cubic feet for curve of how.

^c Cubic capacity reduced 11.3 cubic feet for spare tire and carrier in cargo body.

^d Cubic capacity reduced 16.8 cubic feet for wheel wells.

^e Cubic capacity reduced 4.6 cubic feet for curve of how.

^f Top of hood is higher than steering wheel.

^g Cubic capacity reduced 2.3 cubic feet for wheel wells.

^h Cubic capacity reduced 3.9 cubic feet for curve of bow.

ⁱ Cubic capacity reduced 12.7 cubic feet for wheel wells.

^j Cubic capacity reduced 6.6 cubic feet for curve of bow.

^k Use cube indicated under column headed "top of steering wheel."

^l Cubic capacity reduced 8.5 cubic feet for curve of bow.

^m Cubic capacity reduced 10.7 cubic feet for wheel wells.

ⁿ Cubic capacity reduced 24.0 cubic feet for wheel wells.

3-8. Stowage Capacity of Cargo Semitrailer Van Bodies

Vehicle	Cargo body loading capacities (cu ft) Van body
6-ton capacity	
M119 -----	1018.1
M119A1 -----	1018.1
12-ton capacity	
M128A1C -----	1356.4
M128A2C -----	1356.4
M129 -----	1356.4
M129A1 -----	1356.4
M129A1C -----	1356.4
M129A2C -----	1356.4

3-9. Stowage Capacity of Semitrailer Stake Cargo Bodies

Vehicle	Cargo body loading capacities (cu ft)
6-ton capacity	
M118 -----	663.1
M118A1 -----	656.1
12-ton capacity	
M127 -----	824.8
M127A1 -----	824.8
M127A1C -----	828.3
M127A2C -----	828.3

3-10. Dimensional Data for Cargo Truck Bodies

Vehicle	Length	Cargo deck (in.) Width	Height above ground	Cargo body loading weights (in.)		
				Under bows	Top of side racks	Top of steering wheel
¾-ton capacity						
M37 -----	78.0	64.0	35.2	54.0	35.4	29.3
M37B1 -----	78.0	64.0	35.2	54.0	35.4	29.3
1¼-ton capacity						
M561 -----	87.8	81.0	31.8	62.4	41.1	37.7 ^a
M715 -----	93.8	64.0	33.8	55.5	38.5	25.5
2½-ton capacity						
M34 -----	147.0	80.0	44.0	60.0	36.5	38.0
M35 -----	147.0	88.0	51.7	60.0	36.5	38.0
M35A1 -----	147.0	88.0	52.2	60.0	36.5	28.8
M35A2 -----	147.0	88.0	52.5	60.0	36.5	28.8
M35A2C -----	147.0	88.0	52.5	60.0	36.5	28.8
M36 -----	210.0	88.0	50.7	72.0	36.0	29.8
M36A2 -----	210.0	88.0	50.7	72.0	36.0	29.8
M135 -----	147.0	80.0	44.5	60.0	36.5	35.3
M211 -----	147.0	88.0	51.0	60.0	36.5	26.0
5-ton capacity						
M41 -----	165.0	88.0	49.2	60.0	36.5	38.8
M54 -----	168.0	88.0	56.5	61.3	36.5	29.0
M54A1 -----	168.0	88.0	56.5	61.3	36.5	29.0
M54A2 -----	168.0	88.0	56.5	61.3	36.5	29.0
M54A1C -----	168.0	88.0	56.5	61.3	36.5	29.0
M55 -----	244.0	88.0	55.8	61.3	36.5	29.0
M55A2 -----	244.0	88.0	61.3	61.3	36.5	29.0
M656 -----	179.0	88.0	54.0	60.0	25.0	^b
10-ton capacity						
M125 WVN -----	180.0	96.0	68.0	62.0	42.0	23.8

^a Top of hood is higher than steering wheel.

^b Use cube indicated under column headed "Top of side racks." Side racks are higher than steering wheel.

^c Cubic capacity reduced 27.0 cubic feet for spare tire and carrier in cargo body.

^p Cubic capacity reduced 6.9 cubic feet for curve of bow.

^q Cubic capacity reduced 22.6 cubic feet for spare tire and carrier in cargo body.

^r Cubic capacity reduced 7.0 cubic feet for curve of bow.

^s Cubic capacity reduced 10.2 cubic feet for curve of bow.

^t Use cube indicated under column headed "Top of side racks." Side racks are higher than steering wheel.

^u Cubic capacity reduced 21.9 cubic feet for spare tire and carrier in cargo body.

^v Cubic capacity reduced 7.5 cubic feet for curve of bow.

^w Increased cube (because of top 4.5 inches of side panels being 46.0 inches wide).

^x Cubic capacity reduced 4.6 cubic feet for wheel wells.

^y Cubic capacity reduced 5.6 cubic feet for wheel wells.

^z Cubic capacity reduced 0.5 cubic feet for curve of bow.

3-11. Dimensional Data for Dump Truck Bodies

Vehicle	Cargo deck (in.)			Cargo body loading height (in.)		
	Length	Width	Height above ground	Top of body sides	Top of steering wheel	Top of cab shield
2½-ton capacity						
M47 -----	108.0	70.0	54.5	15.5	27.0	48.5
M59 -----	108.0	70.0	52.8	15.5	26.5	49.0
M215 -----	108.0	70.0	52.0	15.5	26.5	56.0
M34A2 -----	132.0	69.8	54.8	12.5	26.0	50.0
5-ton capacity						
M51 -----	123.0	82.0	59.0	23.0	27.0	51.0
M51A2 -----	123.0	82.0	59.0	23.0	27.0	51.0

3-12. Dimensional Data for Cargo Trailer Bodies

Vehicle	Cargo deck (in.)			Cargo body loading height (in.)		
	Length	Width	Height	Under bows	Top of side racks	Top of side panels
¼-ton capacity						
M100 -----	71.5	37.8	24.5	None	None	18.0
M146 -----	72.0	41.3	26.0	None	None	18.0
¾-ton capacity						
M101 -----	94.8	65.3	31.7	49.0	33.3	18.3
M101A1 -----	94.8	65.3	31.7	49.0	33.3	18.3
1½-ton capacity						
M104 -----	110.0	74.0	38.3	59.3	45.3	18.0
M104A1 -----	110.0	74.0	38.3	59.3	45.3	18.0
M105 -----	109.8	74.0	37.0	60.0	45.0	18.0
M105A1 -----	109.8	74.0	37.0	60.0	45.0	18.0
M105A2 -----	109.8	74.0	37.0	60.0	45.0	18.0

3-13. Dimensional Data for Semitrailer Stake Cargo Bodies

Vehicle	Cargo deck (in.) Length	Width	Cargo body loading height (in.) Top of side racks
6-ton capacity			
M118 -----	268.8	88.8	48.0
M118A1 -----	268.8	88.8	47.5
12-ton capacity			
M127 -----	335.8	88.8	47.8
M127A1 -----	335.8	88.8	47.8
M127A1C -----	335.8	88.8	48.0
M127A2C -----	335.8	88.8	48.0

3-14. Dimensional Data for Cargo Semitrailer Van Bodies

Vehicle	Cargo deck (in.) Length	Width	Cargo body loading height (in.) Under top
6-ton capacity			
M119 -----	264.0	90.3	73.8
M119A1 -----	264.0	90.3	73.8
12-ton capacity			
M128A1C -----	335.5	89.0	78.5
M128A2C -----	335.5	89.0	78.5
M129 -----	335.5	89.0	78.5
M129A1 -----	335.5	89.0	78.5
M129A1C -----	335.5	89.0	78.5
M129A2C -----	335.5	89.0	78.5

Section III. OPERATIONS

3-15. Outline of Standing Operating Procedures for Motor Transport Movements Within Divisions, Logistical Commands, and Higher Echelons

a. General. Policies and factors involved in movements are—

(1) *Highway regulation.* Purpose, application or scope, responsibilities, methods and procedures for accomplishment.

(2) *Convoy clearance.* Minimum vehicle requirements, convoy symbols, procedures, format for requesting and furnishing clearance, routing, halts, convoy composition, restrictions on tracked, overweight, or outsized vehicles.

(3) *Highway regulation points.* Purpose, basis of establishment, responsibilities and procedures for operations, required records.

(4) *Traffic control.* Responsibilities, relationship to highway regulation, coordination measures effected with provost marshal.

(5) *Return loads.* Policies, methods, and procedures for securing and reporting.

(6) *Convoy commanders.* Appointment, responsibilities, and functions; relationships with transportation personnel; instructions to be furnished.

(7) *Halts.* Types, policies, procedures, and responsibilities for establishment and conduct of halts; area policing.

(8) *Security.* Responsibilities and methods of conducting defensive measures.

(9) *Records and reports.* Responsibilities and methods for maintenance of required records, reference to reports to be submitted.

(10) *Communications.* Responsibilities and means of communication.

b. Supply Movements.

(1) *Releases.* When required, methods of obtaining, formats, dissemination, actions required.

(2) *Diversions and reconsignments.* Authority to effect diversions with consideration for various command areas, procedures for initiating requests, and execution.

(3) *Records and reports.* Types of records required to be maintained on supply movements, reference to reports to be submitted.

3-16. Outline of Standing Operating Procedure for Motor Transport Service

a. General. Policies involved in control, operation, and maintenance of facilities, equipment, and installation; command responsibility; technical supervision required and agencies involved.

b. Mission. Service provided, extent of operation.

c. Functions.

(1) Scheduled and nonscheduled operations.

(2) Maintenance of equipment—responsibilities, procedures, facilities, and inspection practices.

d. Operational Planning. Computation of troop and equipment requirements, capability estimate, communication procedure and requirements, rehabilitation requirements.

e. Operations. Operational procedures and controls, pooling and utilization of equipment.

f. Maintenance. Responsibilities and procedures for maintenance, regulations, and reports.

g. Supply Procedure. Responsibilities for supplies, authorized levels, requisitioning procedures, accounting methods, disposal of excesses.

h. Intelligence and Reconnaissance. Responsibility for collection, collation, evaluation, and dissemination of highway transportation intelligence and reconnaissance information.

i. Security. Responsibilities, plans—disaster and defense, convoy and cargo security, equipment and facilities.

j. Records and Reports. Responsibility, operational and personnel status reports, technical reports, miscellaneous.

k. Training. Responsibility—unit and technical training.

3-17. Vehicle Commitment Format

Routine commitment of vehicles requires the type of information outlined below. Those items not required for a particular unit should be eliminated. For nonroutine commitment and

commitment of an entire unit for a substantial period of time, consideration should be given to the use of the five-paragraph operation order (FM 101-5).

a. Heading. The headquarters receiving the commitment, its location, and the date and hour of receipt.

b. Task (or Request).

- (1) Request number _____
- (2) Received from _____
(name and rank) (org) (phone)
- (3) To transport _____
(tons) (type of cargo) (No. pers).
Cube _____ Peculiarities _____
(shape, etc.)
From _____ To _____
- (4) Recommended number and type of vehicles _____
- (5) Terminal capabilities.
Origin _____ Est load time _____
Destination _____
Est unload time _____
- (6) Vehicle report to: _____
(name, rank, title)
Location _____ Phone _____
Time and date: Spot _____
Move _____
- (7) On arrival at destination, report to: _____
(name, rank, title)

c. Coordinating Instructions.

- (1) Type of commitment:
One-time: _____
Recurring: _____
If recurring, from _____
Through _____
- (2) Road information: _____
special routing _____
weather effects, limitations, etc. _____
- (3) Shipment (has) (has not) been coordinated with consignor and consignee, regarding (reference to paragraph numbers above or enter special information).
- (4) It (is) (is not) an emergency movement. If emergency authorized by _____
(name, rank, title, org) Phone _____
- (5) Trailer pickup, movement, and delivery schedule.

(Spot) Pickup trailers at origin at _____

(date-time)

Move trailer from _____
to _____
By date-time _____
Move trailer from _____
to _____
By date-time _____
Deliver trailers to destination for (unloading) (return loading) (return) at _____

(date-time)

d. Administrative and Logistical Matters.

- (1) Class III: (available origin) (available destination) (unit provide own).
- (2) Meals and billets: (available origin) (available destination) (not available).
- (3) Remarks: _____

e. Command and Signal.

- (1) Reports required: _____
- (2) Highway clearance requested _____
(date-time)
_____, received _____
_____, clearance number _____
(date-time)
- (3) Special instructions: _____

3-18. Convoy Briefing

Before a convoy departs on a mission the convoy commander briefs all members of the convoy. The following outlines the areas which should be covered. Adjustments may be made to suit local situations.

a. Situation.

- (1) Friendly forces.
- (2) Support units.
- (3) Enemy situation.

b. Mission.

- (1) Type of cargo.
- (2) Origin.
- (3) Destination.

c. Execution.

- (1) General organization of the convoy.
- (2) Time schedule.
- (3) Routes.
- (4) Convoy speed.
- (5) Catchup speed.

- (6) Vehicle distance.
- (7) Emergency measures.
 - (a) Accidents.
 - (b) Breakdowns.
 - (c) Separation from convoy.
 - (d) Ambush.
 - 1. Action of convoy personnel in the event of ambush.
 - 2. Action of security personnel during ambush.
 - (e) Medical support.
- d. *Administration and Logistics.*
 - (1) Control of personnel.
 - (2) Billeting arrangements.
 - (3) Messing arrangements.
 - (4) Refueling of vehicles.
 - (5) Servicing of vehicles.
- e. *Command and Signal.*
 - (1) Location of convoy commander.
 - (2) Designation of assistant convoy commander.
 - (3) Action of the security forces commander.
 - (4) Serial commanders' responsibility.
 - (5) Arm and hand signals.
 - (6) Other prearranged signals.
 - (7) Radio frequencies and call signs for _____.
 - (a) Control personnel.
 - (b) Security force commander.
 - (c) Fire support elements.
 - (d) Reserver security elements.
 - (e) Medical evacuation support.
- f. *Safety.*
 - (1) Hazards of route and weather conditions.
 - (e) Defensive driving.

3-19. Convoy Commander's Checklist

If each item listed below is checked and acted upon carefully by the convoy commander before departure time, the chances of neglecting some important arrangement will be minimized.

- a. Where is start point? _____ Release point? _____.
- b. What route is to be used? _____

c. Has reconnaissance been made and condition of route determined? _____

d. Can bridges and defiles safely accommodate all loaded and/or tracked vehicles? _____

e. Are critical points known and listed on strip maps? _____

f. Has the size of serials been determined? _____

g. Has the size of march units been determined? _____

h. What will be the rate of march? _____

i. What is the vehicle interval on an open road? _____ In built-up areas? _____ At halt? _____

j. Type of column? _____

k. Has provision been made for refueling if required? _____

l. Has a suitable bivouac site been selected if required? _____

m. Have suitable rest and mess halt areas been selected if required? _____

n. Is road-movement table needed? _____ Prepared? _____ Submitted? _____

o. Have convoy clearances been obtained? _____ What date? _____

p. Is escort required and has it been requested? _____

q. Are spare trucks available for emergencies? _____

r. Are vehicles fully serviced, clean, and ready for loading? _____

s. Is load proper, neat, and balanced? _____

t. Are drivers properly briefed? _____ By whom, when? _____ Strip maps furnished? _____

u. Is convoy marked front and rear of each march unit? _____

v. Are guides in place? _____ Have arrangements been made to post guides? _____

w. Are blackout lights functioning? _____

x. Are maintenance services alerted? _____

y. Is maintenance truck in rear? _____ Are medics in rear? _____ Plan for casualties? _____

z. Are all interested parties advised of ETA?

aa. Is officer at rear of convoy ready to take necessary corrective action, such as investigating accidents and unusual incidents and changing loads? _____ Who is trail officer? _____

ab. Is there an entracking plan? _____ Who is responsible? _____

ac. Is there a detracking plan? _____ Who is responsible? _____

ad. Has a plan been made for feeding personnel? _____

ae. Have times been established for entrucking or loading? _____

af. Has time been established for formation of convoy? _____

ag. Have times been established for detrucking or unloading? _____

ah. Has time been established for releasing trucks? _____ Who is responsible? _____

ai. Is there a carefully conceived plan known to all personnel in the convoy that can be used in case of attack? _____

aj. Is a written operation order on hand if required? _____

ak. Will a log of road movement be required at end of trip? _____ Are the necessary forms on hand? _____

al. Has weather forecast been obtained? _____

am. Do all personnel have proper clothing and equipment? _____

an. Is there a communications plan? _____

3-20. Convoy Commander's Report

The convoy commander prepares this report after a move has been completed and normally submits it to his immediate superior officer. The sample report below may be used as a guide. However, the report may be submitted in the form of a strip map with an appropriate legend attached.

Forward Load	
420 Trans Bn (Trk)	4401 Trans Co (Lt Trk)

7A26FEB23 Twelve 2½-Ton Trucks 16 Feb 72
(Convoy No.) (No. and type of task vehicles) (Date)

Time

Convoy departed starting point (SP) .. 0621

Convoy departed 1st loading point .. 0800

Convoy arrived at 1st loading point ... 0630

Time at 1st loading point .. 1 hr 30 min

Arrived at highway regulation point

(HRP) 1200

Departed HRP 1205

Time at 1st unloading point 33 min

Supplies and Personnel

Cargos (short tons) 50.2

Class of supplies I

Personnel 0

Distance*

Speedometer reading of lead vehicle

(1st loading point) 21,324

Speedometer reading of lead vehicle

(SP) 21,322

Total forward (no load) 2

Speedometer reading of lead vehicle

(1st unloading point) 21,381

Total forward (loaded) 57

Remarks

SP—Company area, RJ 124/167

Weak bridge 6.4 miles east of 1st loading point. Road generally in poor condition between SP and 1st unloading point.

Return Load

Time

Departed 2d loading point 1300

Arrived at 2d loading point (same

as 1st unloading point) 1245

Time at 2d loading point 15 min

Departed 2d unloading point 1415

Arrived at 2d unloading point 1400

Time at 2d unloading point 15 min

Supplies and Personnel

Cargo (short tons) 10

Class of supplies II and IV

Personnel 120

Distance*

Speedometer reading of lead vehicle

(2d unloading point) 21,396

*For explanation, see end of this sample report.

Speedometer reading of lead vehicle
(2d loading point) 21,381
Total return (loaded) 15
Speedometer reading of lead vehicle
(SP) 12,346
Total return (no load) 40

Remarks

Road in excellent condition between 2d loading point and SP.

Round-Trip Data

Time

Time returned to SP 1654
Total round-trip time 10 hr 33 min
Total travel time (including halts) 8 hr
Total loading time 1 hr 45 min
Total unloading time 48 min

Supplies and Personnel

Cargo (short tons of class I) 50.2
(short tons of class II and class
IV) 10

Personnel 120

Distance*

Total distance (loaded) 72
Total distance (unloaded) 42
Total round-trip distance 114

Remarks

s/Thomas A. Yound

(Signature—convoy commander)

2d Lt, 4401 Trans Co (Lt Trk)

(Rank or grade and organization)

3-21. Convoy Clearance

A convoy clearance request usually is required from a unit or organization that is planning a move by convoy. The information required varies according to local SOP and regulations. In CONUS, DD Form 1265 should be used (para 3-24). In a field army, the traffic headquarters prescribes the form, determines routes to be used, and issues road clearances. The sample outline below shows the information usually required by any authority that issues road clearances.

*Distances shown are in miles (multiply by 1.609 to convert to kilometers). Average rate of march=14.2 mih=22.9 kmih. Ton-miles: Forward—2,861; Return—150. Passenger-miles: Forward—0; Return—1,800.

Convoy Clearance Request

From: S3 1429 TTBn

Phone: Barkersville 1429

Time and date: 261530 Oct 61

Authority for movement: MO 341, HQ
TALOG, dated 19 Oct 61

Convoy No.: 12B

Unit name or serial No.: 4406 T Car Co

Personnel: 4 Off, 98 EM

Total number of vehicles: 51 trks, 31 tlrs

Type and number of vehicles: thirty-eight 1/4-ton trks, twenty-five 1/4-ton tlrs, one 3/4-ton trk, four 1 1/2-ton trks, eight 2 1/2-ton trks, six 1-ton tlrs

No. of serials: 3

Vehicles by type and number in serials
(Do not show control, mess, or maintenance vehicles.):

(1) Two 2 1/2-ton trks, twelve 1/4-ton trks,
one 1/2-ton trk, two 1-ton tlrs, eight 1/2-ton tlrs

(2) Same as 1st serial

(3) Same as 1st serial

Vehicle distance: 60 55
(yards) (meters)

Average length of vehicles and/or combinations: 10 9
(yards) (meters)

Gap between serials:

Distance 2,935 2,684 Time 5
(yards) (meters) (min)

Total length of convoy:

Distance 8,840 8,043 Time 15
(yards) (meters) (min)

Cargo and tonnage:¹ 36 tons of baggage and organizational equipment.

Outside or overweight loads: None

SP: Barkersville

Scheduled time and date of departure:
290700 Oct 72

Proposed route: Barkersville, RJ 261, Kennedy, Kleburg, Exeter

Destination: Exeter

Estimated time and date of arrival:
291900 Oct 72

Rate of march: 20 32
(mih) (kmih)

Scheduled halts: 15 min RJ 261; 1 hr Kennedy; 15 min Kleburg

¹ If cargo includes explosives, include data required by local SOP and/or regulations.

Scheduled bivouacs: Arrive NA depart: NA POL points (determined by staff transportation officer): NA

Highway regulation (determined by staff transportation officer): Advised Sgt Harris in office of staff transportation officer, 261015 Oct 72. Clearance granted by Lt Brown, office of staff transportation officer, 261230 Oct 72. Critical points:

Name of Point	ETA	ETD
RJ 261	0900	0915
Kennedy	1215	1315
Kleburg	1615	1630
Exeter	1900	

Remarks: ²

1. POL points not needed. Convoy will be refueled by tankers during halt at Kennedy.
2. Unit commander will insure strict compliance with all SOP and with all highway regulation and control procedures issued by competent authority.

s/George A. Harkins

(Signature)

GEORGE A HARKINS

Capt, S3 1429 TTBn

(Grade, title, and organization)

3-22. Vehicle Loading

a. *Responsibility.* The driver is responsible for his vehicle being loaded properly.

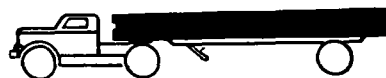
b. *Rules for Loading (Fig. 3-1).*

(1) Place heavy supplies at the bottom of the load and distribute evenly over cargo floor.

² Remarks should include statement of nature and quantity of all logistical support required.

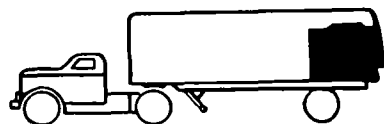


WRONG



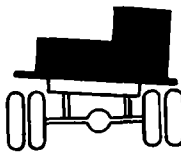
RIGHT

The right vehicle for the right job.



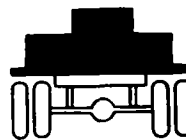
WRONG

This overloads trailer rear wheels, brakes will not brake properly, rubber scuffs away. Distribute the load over the full trailer floor.



WRONG

This overloads one spring and set of tires. Brakes lock on the light side, cause skids.



RIGHT

Nothing overloaded; frame will not twist and loosen cross-member rivets.



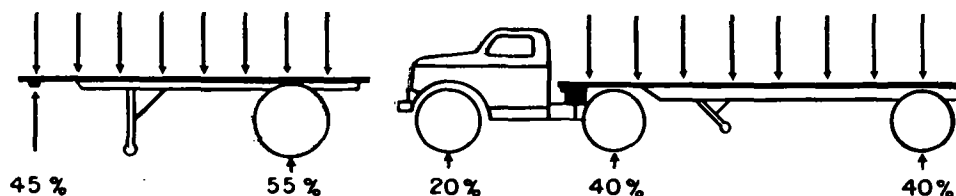
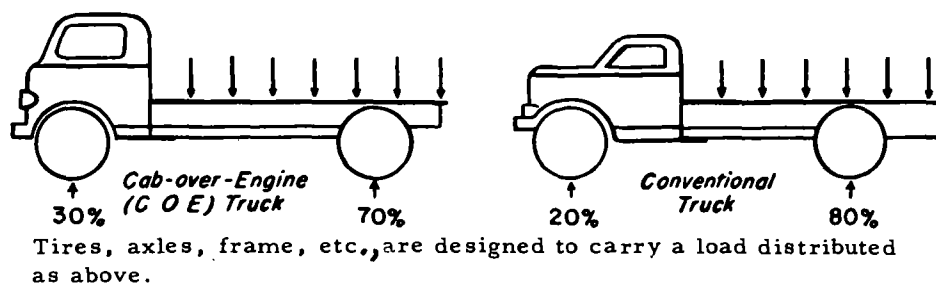
WRONG

This overloads and shortens tire life, bends the truck rear-axle housing. Applying the trailer brakes may lock the wheels and cause flat spots and skidding.

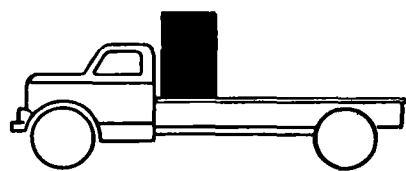


RIGHT

Figure 3-1. How to load a truck.

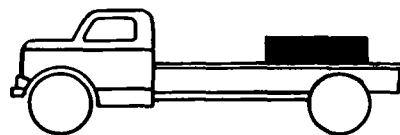


Distribute trailer loads equally between the rear tires and the fifth wheel. This transfers the load to the tractor.



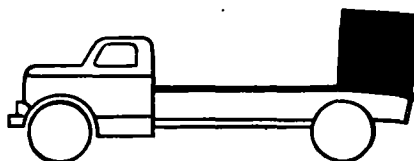
WRONG

This will bend the frame, overload front tires, making steering harder.



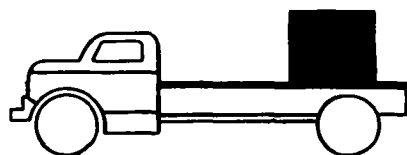
RIGHT

Place heavy part of load near rear axle for proper tire loading and to keep frame from bending.



WRONG

This kind of weight distribution bends the frame, overloads rear tires, and makes steering almost impossible.



RIGHT

Set a concentrated load just ahead of the rear axle with, if possible, the longest side on the floor.

Figure 3-1—Continued.

(2) Place the load so that it will not shift; distribute the weight equally.

(3) Do not distribute load loosely or build it up too high. High, loosely distributed loads cause swaying, make the vehicle difficult to handle, and increase the danger of losing the cargo or overturning the vehicle.

(4) If the truck has an open body, put a tarpaulin, when practicable, over the cargo to protect it against sun, dust, rain, and pilferage.

(5) If possible, place barrels and drums on their sides—parallel with the length of the truck—and brace and pyramid them. If the

possibility of leakage does not permit this placement, set the drums upright. This latter arrangement does not permit the loading of as many drums in the same space.

(6) Combine boxed, crated, and packaged cargo, as far as possible, with like items or items of combining shapes.

(7) Load sacked cargo separately or so as not to risk its being punctured by odd-shaped items; stack it in overlapping layers to prevent shifting.

3-23. Vehicle Size and Weight Limits

The tables below may be used as planning guides. Size and weight limits are changed periodically as a result of road and bridge construction. Planners must check with local military and/or civilian agencies to verify local limits and methods of clearance or exemption before putting vehicles on the road. Maximum allowable axle load, gross weight, and dimensions are contained in tables 3-1, 3-2, and 3-3.

Source: American Trucking Associations, Incorporated. (By permission.)

Table 3-2. Dimensions and Gross Weight

REVISED October 1, 1971

NORTHEASTERN STATES												
STATE	Reciprocity authority (Interstate or international Carriers)	Height	Length in Feet					Axle Load in lbs.	Tandem Axle 4' Apart	Gross Weight in Pounds		
			Truck	Trailer or Semi-Trl.	T.S.T.	T.S.T.T.	Other Comb.			3 Axle T.S.T.	4 or 5 Axle T.S.T.	Highest Weight Possible
Conn.	Full reciprocity except \$20 P.U.C. plate (C)	13' 6"	55	N.S.	55	N.P.	N.P.	22,400 (N)	36,000 (N)	53,800 (N)	67,400 (W)(N)	73,000
Del.	Full reciprocity (C)	13' 6"	40	40	55 (KK)	65	65	20,000	36,000	Table	Table	Table 73,280 Max.
D.C.	Full reciprocity	12' 6"	40	N.R.	55	N.P.	55	22,000	38,000	Table	Table	Table 70,000 Max.
Me.	Full reciprocity except P.U.C. fees (C)	13' 6" (B)	56.5	45	56.5 (BB)	N.P.	56.5	22,000	32,000 (T)	Table 51,800 Max.	Table 66,300 (W)	Table 73,280 Max.
Md.	Full reciprocity (C)	13' 6"	40	55	55 (BB)	65 (AA)	55	22,400	40,000	Table Q 55,000 Max.	Table (W) (Q) 65,000 Max.	Table (Q) 73,280 Max.
Mass.	Full reciprocity (C)	13' 6"	35	N.R.	55	N.P. (M)	N.P.	22,400	36,000	Table	Table 73,000 Max.	Table 73,000 Max.
N.H.	Full reciprocity except P.U.C. fees (C)	13' 6"	35	N.R.	55 (BB)	55	55	22,400	36,000 (E)	Table 52,800 Max.	Table (W) 66,400 Max.	Table 73,280 Max.
N.J.	Full reciprocity (C)	13' 6"	35	N.S. (F)	55	55	55	22,400 (V)	32,000 (V)	Limited by axle (V)	Limited by axle (V)	73,280
N.Y.	Reciprocity on license, none on mileage tax (C)	13' 6"	35	(FF)	55 (KK)	55 (NN)	55	22,400	36,000	34,000+ (L x 1000)	34,000+ (L x 1000) 71,000 Max.	34,000+ (L x 1000) 71,000 Max.
Pa.	Full reciprocity (C)	13' 6"	35	N.S.	55	N.P.	55	22,400 (Q)	36,000 (Q)	50,000 (Q)	60,000 (4 ax.) (W)(Q)	73,280
R.I.	Full reciprocity except P.U.C. fees	13' 6"	40	(FF)	55	N.P.	55	22,400	36,000	50,000	67,400 (W)	73,280
Vt.	Full reciprocity	13' 6"	55	N.S.	55(BB)	N.P.	55	22,400 (T)	36,000	Table	Table	73,280 Max.
SOUTHERN STATES												
Ala.	Full reciprocity except P.S.C. filing fee (C)	13' 6"	40	N.S.	55	N.P.	N.P.	18,000 (U)	36,000 (U)	Table	Table	Table 73,280 Max.
Ark.	Full reciprocity (C) except C.C. filing fees	13' 6"	40	N.S.	55	65	65	18,000	32,000	Limited by axle weight	Limited by axle weight	73,280 Max. (M)
Fla.	Full reciprocity except P.U.C. iden. fee.	13' 6"	35 (K)	(FF)	55	N.P.	55	20,000 (U)	40,000 (U)	Table (U)	Table (U)	Table (U) 66,610 Max.
Ga.	Full reciprocity except P.S.C. fee \$1 (C)	13' 6"	55	55	55 (KK)	55	55	20,340	40,680	Limited by axle weight	Limited by axle weight	73,280 Max.
Ky.	Full reciprocity except certificate and permit fees (S)(C)	13' 6" (M)	35 (M)	N.S.	55 (M) (BB)	65 (M)	55 (M)	18,000 (M) (V)	32,000 (M) (V)	Limited by axle wt. (M)	Limited by axle wt. (M)	73,280 Max. (M)
La.	Full reciprocity (C)	13' 6"	35	N.R.	60	N.P.	65	18,000	32,000	Limited by axle weight	Limited by axle weight	68,000 (J)
Miss.	Full reciprocity except P.S.C. fees (C)	13' 6"	35	N.S.	55	55	55	18,000	28,650 32,000 (M)	Table	Table	Table 73,280 (M)
N.C.	Full reciprocity except P.U.C. filing fee (C)	13' 6"	35 (K)	N.R.	55	N.P.	55	18,000 (P)	36,000 (P)	47,500 (P)	64,000 (P) (W)	70,000 (P)
S.C.	Full reciprocity except P.S.C. fees (C)	13' 6"	35 (K)	N.S.	55 (KK)	N.P.	55	20,000 (R)	32,000 (R)(T)	50,000 (R)	65,000 (W) (R)	73,280 Max.
Tenn.	Full reciprocity (C)	13' 6"	40	N.S.	55 (BB)	N.P.	55	18,000	32,000	Limited by axle	Limited by axle	73,280 Max.
Texas	Full reciprocity except on intangible tax (C)	13' 6"	40	N.S.	65	65	65	18,000	32,000	Table	Table	Table 72,000 Max.
Va.	Full reciprocity except Corp. Comm. registration fee \$2 (C)(S)	13' 6"	35	N.S.	55	N.P.	55	18,000	32,000	Table	Table	Table 70,000 Max.
W. Va.	Full reciprocity except \$3 P.U.C. Card (C)	13' 6" (M)	35 (K)	N.S.	55 (M)	N.P.	55 (M)	18,000 (V)	32,000 (V)	Table (V)	Table (V)	Table (T)(V) 70,000 (M)
CANADIAN PROVINCES												
Alb.	Full reciprocity	13' 6"	35	N.S.	65	65	65	18,000	32,000	42,000 45,000 (OO)	59,000 (M) 74,000 (M)	74,000 (M)
B.C.	Proration only (Y) (C)	13' 6"	35	45 (FF)	65 (M)	65 (M)	65 (M)	20,000	35,000	52,000 (OO)	67,000 (4 ax.) 82,000 (5 ax.) (QQ)	110,000 (QQ)
Man.	Full reciprocity	13' 6"	40	N.S.	60	65	65	18,000	32,000	46,000	60,000 74,000	74,000
N.B.	Full reciprocity except P.U.C. fees (C)	13' 6"	35	45	65	65	65	20,000	35,000	50,000	65,000 (4 ax.) 80,000 (5 ax.)	80,000 125,000 (QQ)
N.S.	Full reciprocity except P.U.C. fees	13' 6"	40	45	65	N.P.	65	18,000 (PP)	32,000 (PP)	49,000 (PP)	(PP) 65,000 (4 ax.) 74,000 (5 ax.)	74,000 (PP)
Ont.	Limited Reciprocity	13' 6"	35	45 (KK)	65	65	65	20,000	35,000	50,000	65,000 (4 ax.) 80,000 (5 ax.)	135,000 (T)
P.E.I.	Full reciprocity except P.U.C. fees	14' 6"	40	N.S.	70	70	70	20,000	35,000	50,000	65,000 (4 ax.) 80,000 (5 ax.)	80,000
Que.	Full reciprocity except P.U.C. fees	13' 6" (M)	35	42.5 (FF)	65	65	65	22,000 (II)	38,000 (II)	54,000 (II)	(II) 76,000 (4 ax.) (II) 86,000 (5 ax.)	86,000 (II)
Sask.	Reciprocity to private carriers and movers	13' 6"	35	N.R.	65	65	65	18,000	32,000	Table	Table	Table 74,000 Max.

REVISED October 1, 1971

MIDWESTERN STATES												
STATE	Reciprocity authority (Interstate or Inter- national Carriers.	Height	Length in Feet					Axle Load in lbs	Tandem Axle 4' Apart	Gross Weight in Pounds		
			Truck	Trailer or Semi-Tri	T.S.T.	T.S.T.T.	Other Comb			3 Axle T.S.T.	4 or 5 Axle T.S.T.	Highest Weight Possible
Ill	Full reciprocity except on C.C. fee (Y) (L)	13' 6"	42	42	55(H) (KK)	65 (AA)	60	18,000	32,000	Table	Table	Table 73,280 Max
Ind	Full reciprocity except P.S.C. Filing Fee (c)	13' 6"	36	N.S.	55 (KK)	65	55	18,000 (X)	32,000 (X)	Limited by axle loads	Limited by axle loads	73,280 Max
Iowa	Full reciprocity (Y)(C)(L) except C.C. fees	13' 6"	35	N.S.	55 (G)	60	55 (G)	18,000 (Z)	32,000 (Z)	Table (Z)	Table (Z)	Table (Z) 72,634 Max
Kans	Full reciprocity (C) (Y)	13' 6"	42.5	FF	55 (KK)	65	65	18,000	32,000	Table	Table	Table 73,280 Max
Mich	Full reciprocity except P.U.C. fees (C) (Y)	13' 6"	40	N.R.	55 (KK)	65 (M)	55	18,000	26,000 (I)	Limited by axle loads	Limited by axle loads	Limited by axle loads
Minn	Full reciprocity (C) (Y)	13' 6"	40	40 (FF)	55	N.P.	55	18,000	32,000	Table	Table	Table 73,280 Max
Mo	Full reciprocity (Y) (C)	13' 6"	40	N.S.	55 (KK)	65 (AA)	65 (AA)	18,000	32,000	Table	Table	Table 73,280 Max
Neb	Full reciprocity (Y) (L) (C)	13' 6"	40	(FF)	60	65	65	18,000 (T) (V)	32,000 (T) (V)	Table (Q)	Table (Q)	Table (Q) 71,146 Max. (T)
N.D.	Reciprocity on vehicles under 24,000 lbs. (Y)(C)	13' 6"	35 (K)	N.R.	60	65 (M)	60	18,000	32,000	750 (L+40)	750 (L+40)	750 (L+40) 73,280 (GG)
Ohio	Full reciprocity except on mileage tax	13' 6"	40	N.S.	55	65	65	19,000	24,000 (O) (Q)	38,000+ (L x 900) (Q)	38,000 + (L x 900) (Q)	38,000 + (L x 900) 78,000 Max. (Q)
Okla	Full reciprocity except P.U.C. filing fee (C)(Y)	13' 6"	40	N.S.	55 (KK)	65	65	18,000	32,000	Table	Table	Table 73,280 Max
S.D.	Full reciprocity (Y) (L) (C)	13' 6"	35	N.S.	65	65 (M)	65 (M)	18,000	32,000	Table	Table	Table 73,280 Max
Wisc.	Full reciprocity except P.S.C. filing fee (Y)(L)	13' 6"	35	35 (HH)	55 (KK)	N.P.	55	19,500	32,000	Table	Table	Table 73,000 Max
WESTERN STATES												
Alaska	Full reciprocity	13' 6"	40	40	60	65	60	20,000	34,000	60,000 Table	80,000 (4 ax.) 85,000 (5 ax.) Table	Table 100,000 (Max.) (GG)
Ariz.	Proration only (Y)(C)	13' 6"	40	N.R.	65	65	65	18,000	32,000	Table	Table	Table 76,800 Max
Calif.	Full reciprocity except Bd. of Equal. fees (Y)(C)	14'	40	40	60 (H)	65	65	18,000	32,000	Table	Table	Table 76,800 Max
Colo.	Reciprocity on registra- tion: none on P.U.C. & mileage tax. (Y) (C)	13' 6" (M)	35	N.S.	65 (M)	65 (M)	65 (M)	18,000	36,000	800 (L+40)	800 (L+40)	800 (L+40)
Haw.	Full reciprocity	13' 6"	40	N.S.	55	65	65	24,000	32,000	800 (L+40)	800 (L+40)	800 (L+40)
Idaho	Authority for full recipri- city but agreements are for proration (Y)(L)(C)	14'	35	N.R.	60 (KK)	65 (AA)	65	18,000	32,000	Table	Table	Table 76,800 Max
Mont.	Full reciprocity except on gross operating revenue tax (Y) (C)	13' 6"	35	N.S.	60 (H)	65 (QQ)	65 (DD)	18,000	32,000	Table	Table	Table 76,800 Max
Nev.	Reciprocity on registra- tion fees: none on P.S.C. fee or mileage tax. (Y)(C)	N.S.	40	N.S.	70	70	70 (AA)	18,000	32,000	Table	Table	Table 76,800 Max
N.M.	Authority for full recipri- city: new agreements on proration (Y) (C)	13' 6"	40	N.R.	65	65	65	21,600	34,320	Table	Table	Table 86,400 Max
Ore.	Reciprocity on license fees: none on P.U.C. plates or mileage tax. (Y)	13' 6" (A)	35	35 (CC)	50 (CC)	65 (CC)	50 (CC)	18,000 (CC)	32,000 (CC)	Table	Table	Table 76,000 (M)
Utah	Heavy vehicles subj. to mileage tax or permits (C)	14'	45	45	60	65 (DD)	65 (QQ)	18,000	33,000	Table	Table	Table 79,900 Max
Wash.	Reciprocity on registra- tion fees: none on P.S.C. and gr. wt. fees. (Y)(C)	13' 6" (A)	35	45	65	65	65	18,000	32,000	Table	Table	Table (T) 72,000 Max
Wyo.	Reciprocity on registra- tion fees: none on mile- age tax. (C)	14'	50	N.S.	75	75	75	18,000 (T)	36,000	Table	Table	Table 73,950 (T)
MEXICO												
Mex.	None	13' 6"	37	N.S.	(MM)	N.P.	60	20,000	32,000	52,000	64,000 (4 ax.) 76,500 (5 ax.)	84,000

- (A) Automobile transporters allowed 13'6"; Washington & Oregon — 14'.
(B) Maine — Load may extend 6" above maximum height.
(C) Have Fuel purchase and reporting law.
(D) Double-bottoms — 65' on 4-lane highways with annual permit.
(E) 40,000 lbs. allowed on tandem axles of single unit when both are drive axles.
(F) N.J. — Trailers 35'.
(G) Iowa — Auto transporters, boat transporters and double-bottoms — 60'.
(H) Calif. stinger-steered truck semi-trailer — 65'; Ill. — 65' on 4-lane and designated highways. Mont. — 70' plus 5' overhang for auto transporters on stinger-steered with permit. Wash. — stinger-steered T.S.T. without load 65'; with load, 70' and non-stinger-steered T.S.T. 60' without load, 65' with load.
(I) On designated highways, 1 pair of tandem axles permitted 32,000 lbs., however, 2 pair of tandem axles permitted 32,000 lbs. on each pair, provided maximum gross combination weight does not exceed 73,280 lbs.
(J) Limit only on load carrying axles — load on steering not considered in limits.
(K) Single units — 40' if equipped with 3 axles, 35' if 2 axles.
(L) Evidence of reciprocity required on vehicles.
(M) Allowed only on designated highways. Mass. and N.Y. permitted on Thruway. Ky. 65' length on toll roads and interstate with permit; Ky. allows auto transporters 60' with permit.
(N) Conn. — 2% tolerance on axle and gross weight; 73,000 lbs. absolute maximum.
(O) Ohio — 32,000 lbs. allowed on axles over 4' apart.

- (P) 1,000 lbs. tolerance on any one axle; 5% tolerance on gross weight.
(Q) Ohio, Pa. & Neb., 3% tolerance. Md. 1000 lb. tolerance. (Pa. 73,280 Max.)
(R) 10% tolerance allowed on gross weight (administered also on axles).
(S) Trucks with 3 axles and all tractors assessed additional road tax of 2¢ per gallon on all fuel used.
(T) W.Va. — May secure permit for weight up to 73,280 lbs., no tolerance allowed; limit on regular W. Va. roads 60,800 lbs. Washington permits up to 76,000 lbs. on certified routes. S.C. and Maine permit 36,000 lbs. tandems on state highways. Vt. allows 5% tolerance on single axles on state highways. Ontario weight on combination limited by number of axles and spacing. Neb. 20,000 single, 34,000 tandems and 95,000 gross on State highways. Wyo. — allows 20,000 on single axle and 101,000 gross on state highways.
(U) 10% tolerance allowed.
(V) 5% tolerance allowed.
(W) Pa. — 5 axles T.S.T. — 73,280 lbs; 4 axle truck full trailer — 62,000 lbs.
N.C. — 5 axle T.S.T. — 70,000 lbs.
Conn. — 5 axle T.S.T. — 73,000 lbs.
Me., Md., R.I., N.H., and S.C. — 5 axles T.S.T. — 73,280 lbs.
(X) Ind. — 22,400 lbs. single & 36,000 lbs. tandem axle permitted on roads designated by Highway Commission.
(Y) Have fleet reciprocity by apportioning license fees.
(Z) 8% tolerance on total gross weight or groups of axles; 3% on single or tandem axles.

- (AA) Mo. — 65' on all primary and interstate highways;
Ill. and Md. — 65' on 4 lane and designated roads.
Idaho permits triples of 98' on designated roads;
Nev. — triples of 105' on designated roads.
(BB) Ky., Me., Md., N.H., Tenn., and Vt., auto transporters permitted overhang or bumper of vehicle being transported.
(CC) Oregon State Highway Commission may grant, by resolution or annual permits, semi-trailer length to 40'; T.S.T. length to 60'; other combination length to 75'; triples of 105'. Axles of 20,000 lbs. single and 34,000 lbs. tandem on all state highways.
(DD) Permit needed for 65'.
(FF) Kans. — 42 1/2' on trailer; N.R. on semitrailer.
Neb. & R.I. — 40' on trailers, N.S. on semitrailers;
Minn. — semitrailers and trailers for live stock, boats and autos — 45'.
Florida and N.Y. — 35' on trailers, N.R. on semitrailers.
B.C. — 40' on trailers.
Que — 45' on full trailers
(GG) N.Q. — need approval on all equipment over 64,000 lbs.
Alaska — gross weight for 8 axle doubles with 60' axle spacing.
(HH) Semitrailer length measured from extreme rear of tractor chassis to rear of trailer.
(II) Quebec — New limits effective March 1, 1972.

- (KK) Auto transporters — 60' in Ga., Mo., & S.C.; 60' with annual permit in Okla., 65' in Del., Idaho and Ind.; 65' with annual permit in Wisc.; Mich. — 60' plus 3' overhang of vehicle or boat transported and 65' on designated highways; 70' in Wyo.; no limit in Ont.; 65' in Ill. on 4 lane and designated highways, 60' on others; N.Y. — 55' plus 5' overhang; and Kan. — 60' plus 3' overhang beyond front and 4' beyond rear.
(MM) Mexico — 3 axle T.S.T. 45'; 4 axle T.S.T. 47'; 5 axle T.S.T. 60'.
(NN) Doubles allowed in N.Y. except in N.Y. City and Nassau and Suffolk Counties. Turn-pike doubles up to 101' on thruway.
(OO) Alb. — with 9,000 lbs. steering; B.C. — with 12,000 lbs. steering; and N.B. — for 8 axle train.
(PP) N.S. — 1,000 lbs. tolerance single axle; 3,000 lbs. tandem.
N.R. Statute specifies no restriction.
N.P. Not permitted.
N.S. Not specified. (Law is silent)
T.S.T. Tractor semi-trailer
T.S.T.T. Doubles.
L — In formula — distance between 1st and last axle.
WIDTH All states 96", except Alb., B.C., Conn., Manitoba, N.B., Ont., R.I., & Sask., 102".
Maine on state highways; Hawaii 108".

*Table 3-3. Turnpike or Toll Road Exceptions—
Maximum Allowed Under Special Permit*

	<i>Length</i>	<i>Gross weight</i>	<i>Number of vehicles in combination</i>
Florida Turnpike	110 ft	138,271 lb	3
Indian Toll Road	98 ft	127,400 lb	3
Kansas Turnpike	105 ft	130,000 lb	3
Massachusetts Toll Road	98 ft	127,400 lb	3
New York Thruway	108 ft	124,400 lb	3
Ohio Turnpike	98 ft	127,400 lb	3
Pennsylvania Turnpike	70 ft	73,280 lb*	3

*Combinations exceeding 73,280 pounds must have written special hauling permit from Turnpike Commission.

Source: American Trucking Associations, Incorporated. (By permission.)

3-24. Requests for Convoy Clearance and Special Hauling Permits (CONUS)

a. Request for convoy clearance must be submitted on DD Form 1265 (Request for Convoy Clearance) (fig. 3-2) through the local transportation officer at the point of origin to the appropriate CONUS Army or Military District of Washington, US Army official; the appropriate official is designated in the "Directory of Defense and State Officials Authorized to Request and Issue Permits for Oversized, Overweight or other Special Movement on Public Highways," published by the Military Traffic Management and Terminal Service. DD Form 1265, a copy of the operation order, and a strip map of the proposed convoy route must be submitted in quadruplicate. An additional copy of each document must be added for each state to be traversed. These

documents must be submitted in time to reach the CONUS Army headquarters or Military District of Washington, US Army 7 workdays prior to the date of movement.

b. Requests for permits to move oversize or overweight vehicles over public roads are submitted in quadruplicate, with one copy added for each state to be traversed, in accordance with procedures outlined in *a* above, on DD Form 1266 (Request for Special Hauling Permit) (fig. 3-3) by the moving unit.

3-25. Safe Operating Distances Between Vehicles

The chart below shows average values which may be used in determining safe gaps between vehicles at various speeds on average, hard-surfaced roads. Since well-trained drivers can reduce the distance traveled during the perception and reaction periods, the planner should consider the physical condition and the state of training of drivers for a particular operation, keeping in mind that rain, snow, distances are based on the assumption that the vehicles are loaded and have good brakes, tires, and traction. Total distances have been determined from the standpoint of safety only; the tactical situation may require larger or smaller gaps. In the absence of definite information, the following rule-of-thumb method may be used for certain speeds to determine the gap between vehicles in a convoy: speedometer reading (mph) $\times 2$ = gap in yards, or speedometer reading (kmph) $\times 1.2$ = gap in meters. This method should be used only for the speeds marked with an asterisk in table 3-4.

REQUEST FOR CONVOY CLEARANCE				DATE	
				1 May 1972	
SECTION I - GENERAL					
1. ORGANIZATION 508th Trans Co (Mdm Trk)		2. STATION Fort Eustis, Virginia 23604		3. CONVOY COMMANDER John J. Jones 1LT, TC	
4. PERSONNEL STRENGTH		5. POINT OF ORIGIN		6. DESTINATION	
a. OFFICER 1	b. ENLISTED 47	Fort Eustis, Virginia		Camp A. P. Hill, Virginia	
7. DATE AND TIME		7a. DEPARTURE 15 0700 May 72	7b. ARRIVAL 15 1002 May 72	8. RATE OF MARCH 40 MIH	
SECTION II - CONVOY COMPOSITION					
9. NUMBER OF EACH TYPE OF VEHICLE AND DESCRIPTION (Exclude towed equipment)					
1 1/4-Ton Truck, Utility					
20 5-Ton Tractor W/19 Stake and Platform Semitrailers (1 Bobtail)					
1 5-Ton Wrecker					
10. TOTAL NUMBER OF VEHICLES 22	11. NUMBER OF OVERSIZE/ OVERWEIGHT VEHICLES 21	12a. NO. OF SERIALS 1	12b. TIME INTERVAL N/A	13a. NO. OF MARCH UNITS 2	13b. TIME INTERVAL 2 min.
SECTION III - ROUTE DATA					
14. PROPOSED ROUTING (Indicate US Routes, State Routes, etc)					
Interstate 64, State Route 168, State Route 33, Interstate 64, Interstate 95, State Route 207, U. S. 301 to Camp A. P. Hill					
15. ETA AND ETD AT STATE LINES, MAJOR ROAD JUNCTIONS, MAJOR BRIDGES AND TUNNELS, METROPOLITAN AREAS AND OVERNIGHT HALT SITES (Continue on a separate sheet if additional space is required)					
LOCATION		ETA	DATE	ETD	DATE
I-64		0700		0705	15 May 72
Rt # 168		0732		0737	
15 Min-Rest Halt. Rt # 33		0754		0814	
I-64		0835		0840	
I-95		0859		0904	
207-301		0857		1002	
SECTION IV - LOGISTICAL DATA					
16. BRIEF GENERAL DESCRIPTION OF CARGO (Brief general description; i. e., organizational impediments, etc.) (Within security limitations)					
Class I (packaged rations)					

DD FORM 1265
1 JAN 69

Figure 3-2. DD Form 1265 (Request for Convoy Clearance).

17. ARE EXPLOSIVES TO BE TRANSPORTED? ☐ YES ☐ NO (If YES, describe below)						
CLASS	AMOUNT	DESCRIPTION	VEHICLES TO BE USED			
			NO.	TYPE		
		N/A				
18. STATEMENT WHY EXPLOSIVES CANNOT BE TRANSPORTED COMMERCIALY (Movements involving explosives and/or other dangerous articles are required to comply with all applicable regulations or directives)						
N/A						
19. LOGISTICAL SUPPORT REQUIRED AT OVERNIGHT HALT SITES? ☐ YES ☐ NO (If YES, complete the following) (Use separate sheet if additional space is required)						
DATE	INSTALLATION	GAS (gals)	OIL (gals)	RATIONS	BILLETS	OTHER
	N/A					
20. REMARKS						
<u>ETA</u> is the time the first vehicle clears the referenced point. <u>ETD</u> is the time the last vehicle clears the referenced point.						
21. REQUESTING AGENCY			22. APPROVING AGENCY			
508th Trans Co (Mdm Trk)						
23. REQUESTED BY (Typed name, grade and title)			24. APPROVED BY (Typed name, grade and title)			
CHARLES C. CHESNUT						
25. DATE	26. SIGNATURE		27. DATE	28. SIGNATURE		
1 May 72						
INSTRUCTIONS: In cases where bona-fide emergencies exist, the information contained on DD Form 1265 and DD Form 1266 may be transmitted to the appropriate headquarters by telephone or electric transmission. In this event, reference will be made to item numbers in the sequence in which they appear on the form. Items which do not apply will be so indicated.						

Figure 3-2—Continued.

REQUEST FOR SPECIAL HAULING PERMIT							DATE 1 May 1972
SECTION I - GENERAL							
1. ORGANIZATION 508th Trans Co (Mdm Trk)		2. STATION Fort Eustis, Virginia 23604			3. DATE OF MOVEMENT		
					4. STARTING 15 0700 May 72	5. COMPLETION 15 1002 May 72	
6. POINT OF ORIGIN Fort Eustis, Virginia				7. DESTINATION Camp A. P. Hill			
8. ARRIVAL AT STATE LINES				9. ROUTING (Stipulate US Route, State Route, etc.)			
DATE		TIME		STATE LINE			
N/A						I-64, Va. 168, Va. 33, I-64, I-95, Va. 207, U. S. 301	
10. ESCORT REQUIREMENTS None							
SECTION II - VEHICLE AND LOAD DATA							
DESCRIPTION (a)	TYPE (2-ton etc) (b)	NO. OF VEHICLES (c)	REGISTRATION NUMBER (d)	HEIGHT (e)	WIDTH (f)	LENGTH (g)	WEIGHT (h)
11. VEHICLE							
A. TRUCK							(Empty)
B. TRUCK-TRACTOR	5-ton	19	list attached	103.5 in	98.3 in	273 in	(Empty) 18996
C. TRAILER							(Empty)
D. SEMI-TRAILER	12-ton	19	list attached	60.5	97.3	345.5	(Empty) 14240
E. OTHER (Specify)							(Empty)
12. LOAD							
13. OVERALL (Vehicle and load)							
				103.5	98.3	554	(Gross) 53236
14. DESCRIPTION OF LOAD (Brief general description: Organization impediments, etc.) (Within security limitations)							
Load consists of packaged class I.							
Load does not exceed cargo body dimensions.							
15. LOAD OVERHANG		16. FRONT		17. REAR		18. LEFT SIDE	
						19. RIGHT SIDE	

DD FORM 1266

Figure 3-3. DD Form 1266 (Request for Special Hauling Permit).

14. NUMBER OF AXLES	(1)	A	(2)	B	()	C	()	D	()	E	()	F	()	G	()
	AXLE 1 a	AXLE 2 b	AXLE 3 c	AXLE 4 d	AXLE 5 e	AXLE 6 f	AXLE 7 g	AXLE 8 h	TOTAL i						
15. NUMBER OF TIRES	2	4	4	4	4										
16. TIRE WIDTH (Inches)	20	20	20	20	20										
17. TIRE SIZES	1100	1100	1100	1100	1100										
18. AXLE LOAD (Empty)	6332	9892	9892	3560	3560										
19. AXLE LOAD (Loaded)	6332	14892	14892	8560	8560										
20. AXLE SPACING (See Item 14 for Identification)	A SPACING 140 in.	B SPACING 54 in.	C SPACING 269 in.	D SPACING 45 in.	E SPACING	F SPACING	G SPACING								
21. REMARKS															
22. MOVEMENT BY HIGHWAY IS ☐ ESSENTIAL TO NATIONAL DEFENSE ☒ IN THE INTEREST OF NATIONAL DEFENSE															
23. REQUESTING AGENCY 508th Trans Co (Mdm Trk)					24. APPROVING AGENCY										
25. REQUESTED BY (Typed name, grade and title) CHARLES C. CHESNUT					26. APPROVED BY (Typed name, grade and title)										
27. DATE 1 May 72		28. SIGNATURE			29. DATE		30. SIGNATURE								
INSTRUCTIONS															
GENERAL: DD Form 1266 "Request for Special Hauling Permit" will be used to obtain special hauling permits for the movement of oversize/overweight vehicles over public highways when accompanying a convoy or when traveling separately. This form, in duplicate and accompanied by letter of transmittal, will be forwarded through the local transportation officer so as to reach the appropriate headquarters not less than ten (10) working days prior to the starting date of the movement. Letters of transmittal will contain complete itinerary and explanation of the movement. One (1) letter of transmittal is sufficient when several DD Forms 1265 and 1266 involving one (1) movement are forwarded to the appropriate headquarters. In cases where bona-fide emergencies exist, the information contained in this form and DD Form 1265 may be transmitted to the appropriate headquarters by telephone or electric transmission. In this event, reference will be made					to item numbers in the sequence in which they appear on the forms. Items which do not apply will be so indicated. SPECIFIC: Item 9A, B, C, and D - Complete nomenclature of vehicles involved. More than one unit may be included, provided units are identical in equipment, load characteristics, routing and movement date. Total number of units shall be indicated prominently. Item 9E - Note all units other than standard highway vehicles; road equipment, guns, etc. Item 9 (d) - Indicate the registration number for each unit or combination of units. Use additional page if required. Item 14 - Indicate appropriate number of axles by inserting number in proper circles. Block out circles not applicable. Item 21 - For movement through the District of Columbia, include name of manufacturer of equipment.										

Figure 3-3—Continued.

Table 3-4. Average Distance Required for Stopping

mph	Speed kmph	ft/sec	Perception feet	meters	Reaction feet	meters	Braking feet	meters	feet	Total ¹ yards	meters
Passenger vehicles ²											
20*	32.2*	29.3	22	6.7	22	6.7	25	7.6	69	33	21.0
25*	40.3*	36.7	28	8.5	28	8.5	35	10.7	91	30	27.7
30*	48.3*	44.0	33	10.0	33	10.0	48	14.6	114	38	34.6
35*	56.3*	51.3	39	11.9	39	11.9	67	20.4	145	48	44.2
40*	64.4*	58.7	44	13.4	44	13.4	90	27.4	178	59	54.2
45*	72.4*	66.0	50	15.3	50	15.3	117	35.7	217	73	66.3
50*	80.5*	73.4	55	16.8	55	16.8	148	45.2	258	86	78.8
55	88.5	80.7	61	18.6	61	18.6	185	56.4	307	102	93.6
60	96.6	88.0	66	20.1	66	20.1	228	69.6	360	120	109.8
65	104.6	95.4	72	21.9	72	21.9	275	83.9	419	140	127.7
70	112.6	102.7	77	23.5	77	23.5	332	102.5	486	162	149.5
Single-unit vehicles with gross weight less than 10,000 pounds											
20*	32.2*	29.3	22	6.7	22	6.7	30	9.2	74	25	22.6
25*	40.3*	36.7	28	8.5	28	8.5	42	12.9	98	33	29.8
30*	48.3*	44.0	33	10.0	33	10.0	58	17.7	124	41	37.7
35*	56.3*	51.3	39	11.9	39	11.9	80	24.4	158	53	48.2
40*	64.4*	58.7	44	13.4	44	13.4	106	31.4	194	65	58.2
45*	72.4*	66.0	50	15.3	50	15.3	138	42.1	238	79	72.7
50	80.5	73.4	55	16.8	55	16.8	177	54.0	287	96	87.6
55	88.5	80.7	61	18.6	61	18.6	222	67.5	344	115	104.7
60	96.6	88.0	66	20.1	66	20.1	273	83.3	405	135	123.5
Single-unit, 2-axle vehicles with gross weight of 10,000 pounds or more											
20*	32.2*	29.3	22	6.7	22	6.7	40	12.2	84	28	25.6
25*	40.3*	36.7	28	8.5	28	8.5	64	19.5	120	40	36.5
30*	48.3	44.0	33	10.0	33	10.0	92	28.0	158	53	48.0
35	56.3	51.3	39	11.9	39	11.9	126	38.4	204	68	62.2
40	64.4	58.7	44	13.4	44	13.4	165	50.3	253	84	77.1
45	72.4	66.0	50	15.3	50	15.3	208	63.4	308	103	94.0
50	80.5	73.4	55	16.8	55	16.8	256	78.1	366	122	111.7
55	88.5	80.7	61	18.6	61	18.6	310	94.5	432	144	131.7
60	96.6	88.0	66	20.1	66	20.1	372	113.5	504	168	153.7
Single-unit vehicles with more than 2 axles and combination of vehicles (tractor truck, semitrailer, and trailer) with gross weight of 10,000 pounds or more											
20*	32.2*	29.3	22	6.7	22	6.7	50	15.3	94	32	28.7
25	40.3	36.7	28	8.5	28	8.5	80	24.4	136	45	41.4
30	48.3	44.0	33	10.0	33	10.0	115	35.1	181	60	55.1
35	56.3	51.3	39	11.9	39	11.9	157	47.9	235	78	71.7
40	64.4	58.7	44	13.4	44	13.4	205	62.5	293	98	89.3
45	72.4	66.0	50	15.3	50	15.3	260	79.3	360	120	109.9
50	80.5	73.4	55	16.8	55	16.8	320	97.6	430	143	131.2
55	88.5	80.7	61	18.6	61	18.6	388	118.3	510	170	155.5
60	96.6	88.0	66	20.1	66	20.1	465	141.9	597	199	182.1

¹ Add 30 feet, or 10 yards, or 9 meters to each total stopping distance shown when determining actual gap to use between vehicles.

² Does not include buses. For this type of passenger-carrying vehicle, select figures from an applicable section in the remainder of the chart.

* Rule-of-thumb method for determining the gap between vehicles in a convoy may be used for speeds marked with an asterisk.

3-26. Route Reconnaissance

a. Route Reconnaissance Overlay. Information obtained by either a hasty or a deliberate reconnaissance can be conveyed to interested personnel on a route reconnaissance overlay. The route reconnaissance overlay is an accurate and concise report of the conditions affecting traffic flow along a specified route and is the preferred method of preparing a route reconnaissance report. An overlay normally satisfies the requirements of hasty route reconnaissance. If, however, more detail is required to support the reconnaissance, the overlay is supplemented with written reports describing critical route characteristics in more detail. For additional information, see FM 5-36. An example of a route reconnaissance overlay is shown in figure 3-4.

b. Route Reconnaissance Checklist. To insure that critical terrain data are not overlooked during route reconnaissance and to aid in the preparation of reconnaissance reports, a checklist based on the characteristics of the area of operations is recommended. The following items should be considered when preparing reconnaissance reports:

(1) Identification and location of the rec-

onnoitered route.

(2) Distance between points easily recognized both on the ground and on the map.

(3) Percent of slope and length of grades which are 7 percent or greater.

(4) Sharp curves whose radii are 100 feet (30 m) or less.

(5) Bridge military load classifications and limiting dimensions, suitable bypasses.

(6) Locations and limiting data of fords and ferries.

(7) Route restrictions, such as underpasses, which are below minimum standard and, if appropriate, the distances such restrictions extend.

(8) Locations and limiting dimensions of tunnels, suitable bypasses.

(9) Suitable areas for short halts and bivouacs which offer drive-off facilities, adequate dispersion, cover, and concealment.

(10) Areas of rockfalls and rockslides which may present a traffic hazard.

c. Route Reconnaissance Symbols. Figure 3-5 provides a summary of standard route reconnaissance and related symbols. In addition, references which explain the symbol in greater detail are provided for each entry.

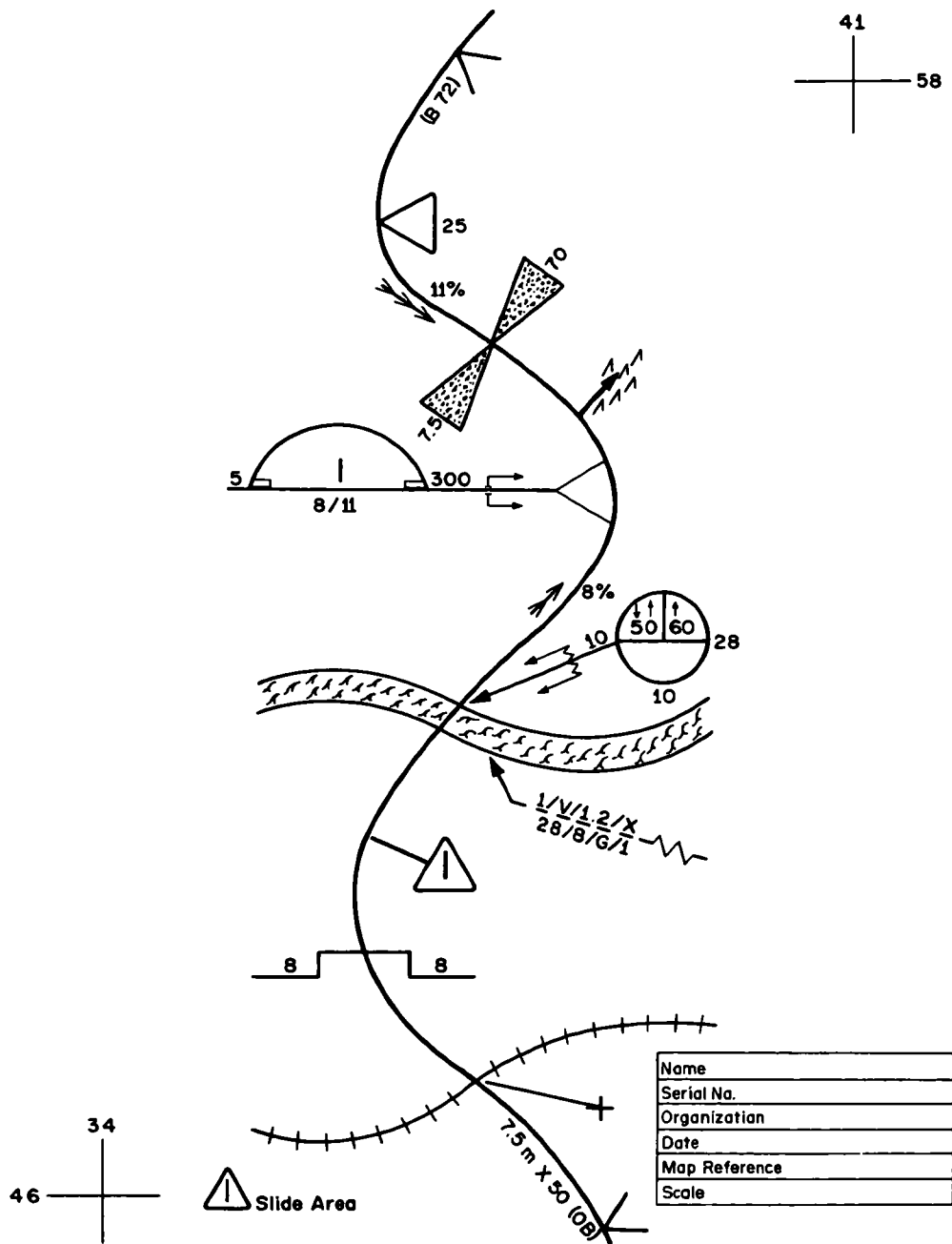


Figure 3-4. Example of route reconnaissance overlay.

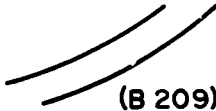
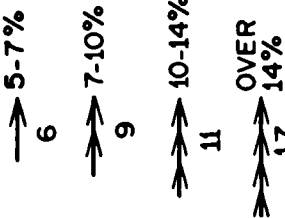
Explanation	Symbol	Remarks	Reference
Civil or military route designation		Designation written in parentheses along route.	STANAG 2253 SOLOG 96
Critical point		To be numbered and described in legend. Critical points may be used to point out features not adequately covered in other reconnaissance symbols.	STANAG 2253 SOLOG 96
Limits of sector		Limits of reconnoitered sector of route.	STANAG 2253 SOLOG 96
Route classification formula	10.5m X 120 6m Z 8 (OB) 9m Y 20 (OB)(W)	Expressed in order of: width, type, military load classification, obstructions, if present, and regular flooding or snow blockage: X - all weather route Y - all weather route (limited traffic) Z - fair weather route (T) - regular snow blockage (W) - regular flooding	FM 5-36 (Sec I, Ch 2) NATO and CENTO STANAG 2015 SOLOG 53
Grades		Arrows point in uphill direction; to the right of symbol is shown the actual percent of slope; length of arrow represents length of grade if map scale permits.	FM 5-36 (Sec III, Ch 2) STANAG 2253 SOLOG 96

Figure 3-5. Route reconnaissance symbols.

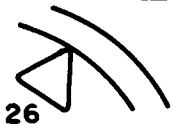
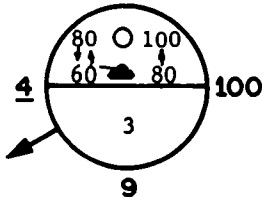
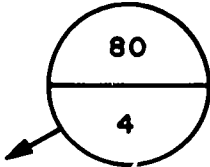
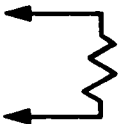
Explanation	Symbol	Remarks	Reference
Sharp curve		Vertex of triangle points to map location of curve. Figure indicates radius in meters.	FM 5-36 (Sec II, Ch 2) STANAG 2253 SOLOG 96
Series of sharp curves		Left figure indicates number of curves; right figure the radius in meters of the sharpest curve.	FM 5-36 (Sec II, Ch 2) STANAG 2253 SOLOG 96
Full bridge symbol		Arrow extends to map location of bridge; minimum width is placed below, overhead clearance to the left, and overall length to the right of basic symbol. Lower portion of symbol indicates bridge serial number; upper portion, military load classification data. Underlined values are those below minimum standard. All linear distances are in meters.	FM 5-36 (Sec VII, Ch 2) DA Form 1295 STANAG 2096 STANAG 2253 SOLOG 96 SOLOG 107 SEASTAG 2096
Abbreviated bridge symbol		Arrow extends to map location of bridge. Lower portion of symbol indicates bridge serial number; upper portion, military load classification. Class number must be underlined if width or overhead clearance is below minimum standard.	FM 5-36 (Sec VI, Ch 2) DA Form 1294 STANAG 2096 STANAG 2253 SOLOG 96 SOLOG 107 SEASTAG 2096
Bypass easy		Used in conjunction with bridge and tunnel reconnaissance symbols.	FM 5-36 (Sec VII, Ch 2) STANAG 2253 SOLOG 96
Bypass difficult		Used in conjunction with bridge and tunnel reconnaissance symbols.	FM 5-36 (Sec VII, Ch 2) STANAG 2253 SOLOG 96

Figure 3-5—Continued.

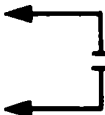
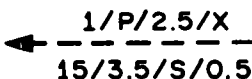
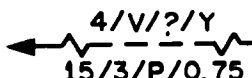
Explanation	Symbol	Remarks	Reference																					
Bypass impossib ¹ o		Used in conjunction with bridge and tunnel reconnaissance symbols.	FM 5-36 (Sec VII, Ch 2) STANAG 2253 SOLOG 96																					
Ford	 	Arrow extends to ford location. Data above the line expressed in order of serial number, ford type, stream velocity, in meters per second, and seasonal limitations. Data below the line expressed in order of length (meters), width (meters), bottom type, and depth (meters). Question marks indicate unknown information. Difficult approaches are represented by zigzag lines corresponding in position to shore where approach is located. <table><tr><th><u>FORD TYPE</u></th><th><u>SEASONAL LIMITING FACTORS</u></th><th><u>BOTTOM TYPE</u></th></tr><tr><td>V-vehicular</td><td>X-none</td><td>M-mud</td></tr><tr><td>P-pedestrian</td><td>Y-significant</td><td>C-clay</td></tr><tr><td></td><td></td><td>S-sand</td></tr><tr><td></td><td></td><td>G-gravel</td></tr><tr><td></td><td></td><td>R-rock</td></tr><tr><td></td><td></td><td>P-artificial paving</td></tr></table>	<u>FORD TYPE</u>	<u>SEASONAL LIMITING FACTORS</u>	<u>BOTTOM TYPE</u>	V-vehicular	X-none	M-mud	P-pedestrian	Y-significant	C-clay			S-sand			G-gravel			R-rock			P-artificial paving	FM 5-36 (Sec V, Ch 2) DA Form 1251 STANAG 2096 STANAG 2253 SOLOG 96 SOLOG 107 SEASTAG 2096
<u>FORD TYPE</u>	<u>SEASONAL LIMITING FACTORS</u>	<u>BOTTOM TYPE</u>																						
V-vehicular	X-none	M-mud																						
P-pedestrian	Y-significant	C-clay																						
		S-sand																						
		G-gravel																						
		R-rock																						
		P-artificial paving																						

Figure 3-5—Continued.

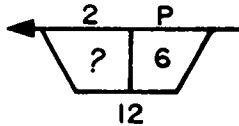
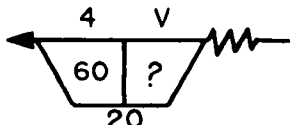
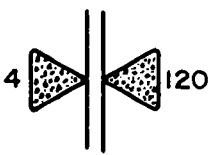
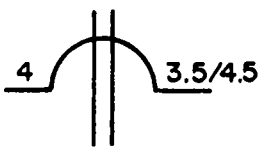
Explanation	Symbol	Remarks	Reference
Ferry	 	Arrow extends to map location. Data above symbol is expressed in order of ferry serial number and ferry type. Data inside symbol is expressed in order of military load class of deck and dead weight capacity in tons; data below symbol is turn around time in minutes. Question mark indicates unknown information. Difficult approaches are represented by zigzag lines corresponding in position to shore where approach is located. <u>FERRY TYPE</u> V-vehicular P-pedestrian	FM 5-36 (Sec V, Ch 2) DA Form 1252 STANAG 2096 STANAG 2253 SOLOG 96 SOLOG 107 SEASTAG 2096
Width constriction		Route constriction. The figure to the left indicates the width of the constriction; that to the right the total constricted length; both dimensions are in meters.	FM 5-36 (Sec IV, Ch 2) STANAG 2253 SOLOG 96
Arch underpass constriction		Width to left of symbol, overhead clearance to the right, both in meters. Both minimum and maximum overhead clearances, if different, will be given.	FM 5-36 (Sec V, Ch 2) STANAG 2253 SOLOG 96

Figure 3-5—Continued.

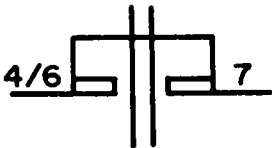
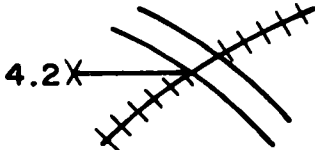
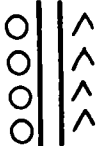
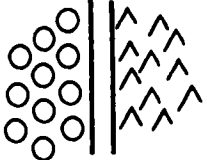
Explanation	Symbol	Remarks	Reference
Rectangular underpass constriction with sidewalks		Width of traveled way followed by total width including sidewalk to left of symbol, overhead clearance to right, dimensions in meters.	FM 5-36 (Sec IV, Ch 2) STANAG 2253 SOLOG 96
Tunnel with sidewalks		Arrow extends to map location. Serial number is placed inside the symbol. The width of the traveled way followed by total width including sidewalks (in meters) is placed below the symbol. Overhead clearance is placed to the left of the symbol and total tunnel length to the right, both in meters. A question mark represents unknown information. Bypasses are shown by standard symbol notations.	FM 5-36 (Sec IV, Ch 2) DA Form 1250 STANAG 2096 STANAG 2253 SOLOG 96 SOLOG 107 SEASTAG 2096
Railroad grade crossing		Level crossing; passing trains will interrupt traffic flow. The figure indicates height, in meters, of power line (if any) above the ground.	STANAG 2253 SOLOG 96
Concealment		Road lined with trees; deciduous trees (left) and evergreen (right).	STANAG 2253 SOLOG 96
Concealment		Woods bordering road; deciduous trees (left), evergreen trees (right).	STANAG 2253 SOLOG 96

Figure 3-5—Continued.

Explanation	Symbol	Remarks	Reference
Possibility of driving off road. The symbol may be amplified as follows: a. Wheeled vehicle b. Tracked vehicle c. A length of road exceeding 1 km where driving off is possible		Arrow indicates direction of turnoff. The figure indicates the length in meters of the turnoff.	STANAG 2253 SOLOG 96
Roadblock, craters, and blown bridges a. Proposed b. Prepared but passable c. Completed		Center of the symbol indicates position of block.	FM 21-30 NATO and CENTO STANAG 2019 SOLOG 28 SEASTAG 2019
Lateral route		Broken lines; identified by even number.	FM 5-36 (Sec I, Ch 2) NATO and CENTO STANAG 2151
Axial route		Solid line; identified by odd number.	FM 5-36 (Sec I, Ch 2) NATO and CENTO STANAG 2151
Unknown or doubtful information			FM 21-30 NATO and CENTO STANAG 2019 SOLOG 28 SEASTAG 2019
Parking area			FM 21-30 NATO and CENTO STANAG 2019 SOLOG 28 SEASTAG 2019
Traffic control post			FM 21-30 NATO and CENTO STANAG 2019 SOLOG 28 SEASTAG 2019
Traffic control headquarters			FM 21-30 NATO and CENTO STANAG 2019 SOLOG 28 SEASTAG 2019

Figure 3-5—Continued.

of movement; location of boundaries, units, highway regulation points, traffic control posts, and principal supply activities; major geographic features; and light lines, if applicable.

d. Circulation plans frequently consist of a standard map and an overlay which together give the needed information. If the necessary information is too much to put on one overlay, separate overlays may be used to show different types of information. The sketch in figure 3-6 is one example of a traffic circulation plan. When making a traffic circulation plan, the planner or operator must be guided by what information is required by users of the plan.

3-28. Route Classification

For the purpose of classification, routes are designated by their ability to withstand the effects of weather. Route type is determined by the worst section of the route. Routes as classified by types are—

a. *Type X.* All-weather route is any which, with reasonable maintenance, is passable throughout the year to traffic never appreciably less than maximum capacity. The roads on this type route normally have waterproof surfaces and are only slightly affected by precipitation or temperature fluctuations. At no time is the route closed to traffic by weather effects other than temporary snow or flood blockage.

b. *Type Y.* All-weather route (limited traffic due to weather) is any route which, with reasonable maintenance, can be kept open in all weather but sometimes only to traffic considerably less than maximum capacity. The roads on this type route usually do not have waterproof surfaces and are considerably affected by precipitation or temperature fluctuations. Traffic may be completely halted for short periods. Heavy, unrestricted use during adverse weather may cause complete collapse of the surface.

c. *Type Z.* Fair weather route is any route which quickly becomes impassable in adverse weather and cannot be kept open by maintenance short of major construction. This category of route is so seriously affected by weather that traffic may be brought to a halt for long periods.

3-29. Military Load Classification

The military load classification system is a load-capacity rating system based on vehicle type, weight, and effect on routes and bridges. In this classification system, whole numbers are assigned vehicles, bridges, and routes. (For detailed discussion, see FM 5-36.) Most allied military vehicles are externally marked with their respective classification number. Bridges and routes are assigned military load classification based on their safe load capacity and physical dimensions.

a. *Route Classification.* Normally, the lowest bridge military load classification number regardless of vehicle type or conditions of traffic flow determines the military load classification of a route. Selection of the lowest bridge classification number insures that the route will not be overloaded. When a proposed route has a lower military load classification than that of the vehicles which must traverse it, this fact is shown on the route reconnaissance overlay, and a special reconnaissance is made to determine if a change in traffic control procedures, such as a single-flow crossing, would make it safe for use by such vehicles. If no bridge is located on the route and the roads are particularly bad, the worst section of road governs the route's classification.

b. *Obstructions to Traffic Flow.* Route obstructions are factors which restrict the type and amount or speed of traffic flow. Route obstructions, with the exception of bridge capacities, which are reported separately as a military load classification, are indicated in the route classification formula (para 3-30) by the abbreviation OB. Moreover, reconnaissance symbols are used to describe the nature of each obstruction on the route reconnaissance overlay. Obstructions to be reported include—

(1) Overhead obstructions, such as bridges, tunnels, underpasses, overhead wires, and overhanging buildings whose overhead clearance is less than 14 feet (4.25 m).

(2) Reduction in traveled-way widths which are below standard minimums prescribed for the type of traffic flow (single or double, wheeled or tracked, see FM 5-36). Examples are bridges, tunnels, craters, lanes through

mined areas, and projecting buildings or rubble.

(3) Gradients (slopes) of 7 percent or greater.

(4) Curves whose radii of curvature are less than 100 feet (30 m).

(5) Ferries.

(6) Fords.

3-30. Route Classification Formula

The route classification formula is developed from notations expressed in the standardized sequence of minimum traveled-way width, route type, lowest military load classification, and obstruction(s) if present. The formula briefly describes a specific route and is used together with a route reconnaissance overlay. If an obstruction(s) appears in the route classification formula, it is necessary to refer to the route reconnaissance overlay in order to determine the exact nature and location of the obstruction(s). Illustrative formulas are shown in *a* through *d* below.

a. 20 Ft Z 10. This example formula describes a fairweather route with a minimum traveled way of 20 feet and a military load classification of 10. This route, based on its minimum width of traveled way accommodates both wheeled and tracked, single-flow traffic without obstruction. Minimum route widths, according to STANAG 2151, for wheeled and tracked vehicles in single and double flow traffic are tabulated below.

Traffic flow possibilities	Route Widths (STANAG 2151)	Widths for tracked vehicles
	Widths for wheeled vehicles	
Single flow	18 to 3 feet (5.5 to 7 m).	19.5 to 26 feet (6 to 8 m).
Double flow	Over 23 feet (7 m).	Over 26 feet (8 m).

b. 20 Ft Z 10 (OB). This example formula describes a route with similar characteristics as in *a* above, but with obstruction(s). It should be noted that 20 feet of traveled way limits this route to single-flow traffic without a width obstruction. If the route is to be used for double-flow traffic, however, 20 feet of traveled way constitutes an obstruction and is indicated in the formula both as a minimum traveled-way width (20 ft) and as an obstruction.

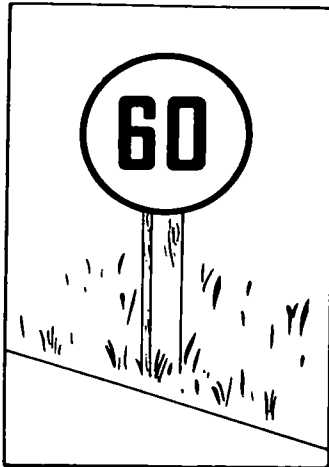
c. 7M Y 50 (OB). This example formula describes a limited all-weather route with a minimum traveled-way width of 7 meters and a military load classification of 50 with obstruction(s). The traveled-way width of this route is adequate for wheeled, but not tracked, vehicles in double-flow traffic. Therefore, this width construction is indicated as (OB) in the route classification formula if the route is to be used for both types of vehicles.

d. 10.5 × 120 (OB). This example formula describes an all-weather route with a minimum traveled-way width of 10.5 meters, which is suitable for double-flow traffic of both wheeled and tracked vehicles, a military load classification of 120 with obstruction(s).

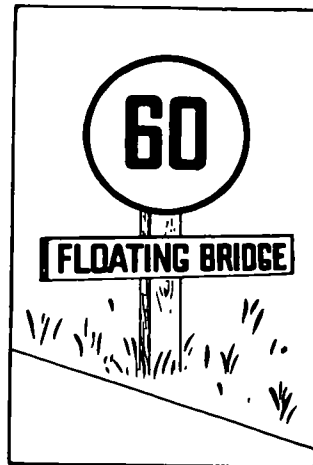
3-31. Bridge Signs

a. Circular Signs (Figs. 3-7 and 3-8). These are placed at bridges to indicate the bridge classification. The signs have a yellow background; the bridge classification and appropriate symbol are in black.

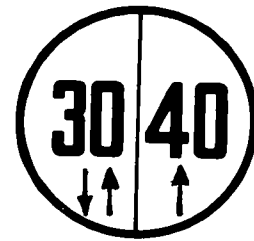
b. Rectangular Signs (Figs. 3-9 and 3-10). These signs give additional instructions and technical information. Minimum size is 16 inches by 16 inches. They have a yellow background and black symbols and lettering.



For single-lane fixed bridge.



For single-lane floating bridge.



Two-way sign limiting vehicle classes on a two-lane bridge when used as a two- or as a single-lane bridge.

Figure 3-7. Typical bridge-class and information signs.

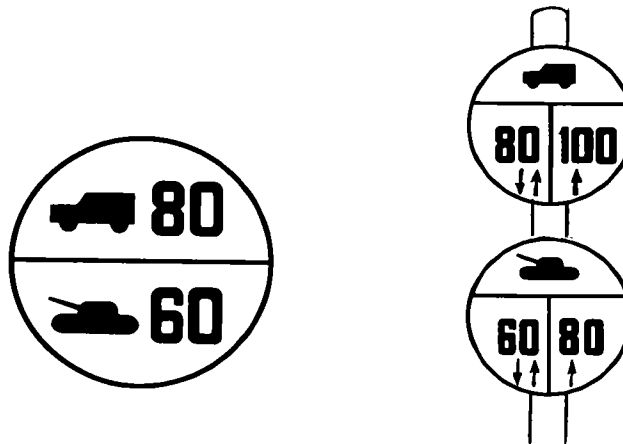


Figure 3-8. Typical dual-class bridge signs.

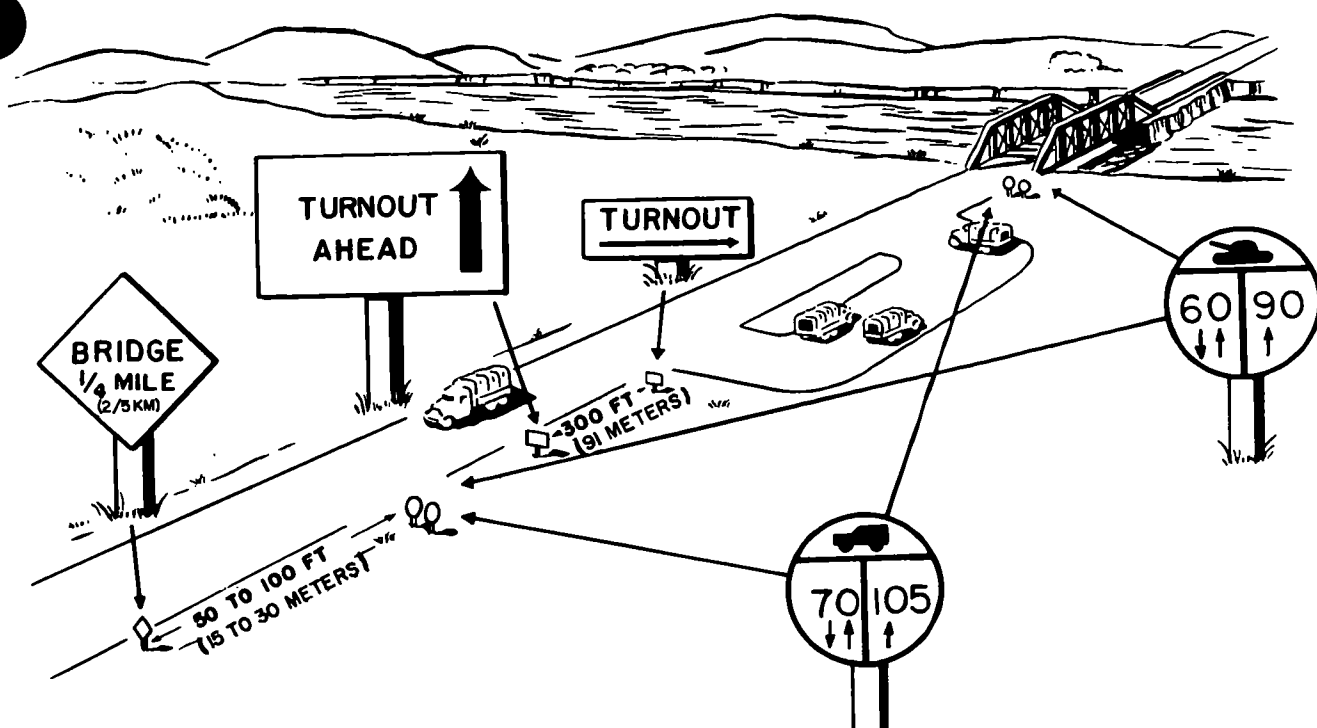


Figure 3-9. Typical arrangement of road-guide information and two-lane bridge-class signs.

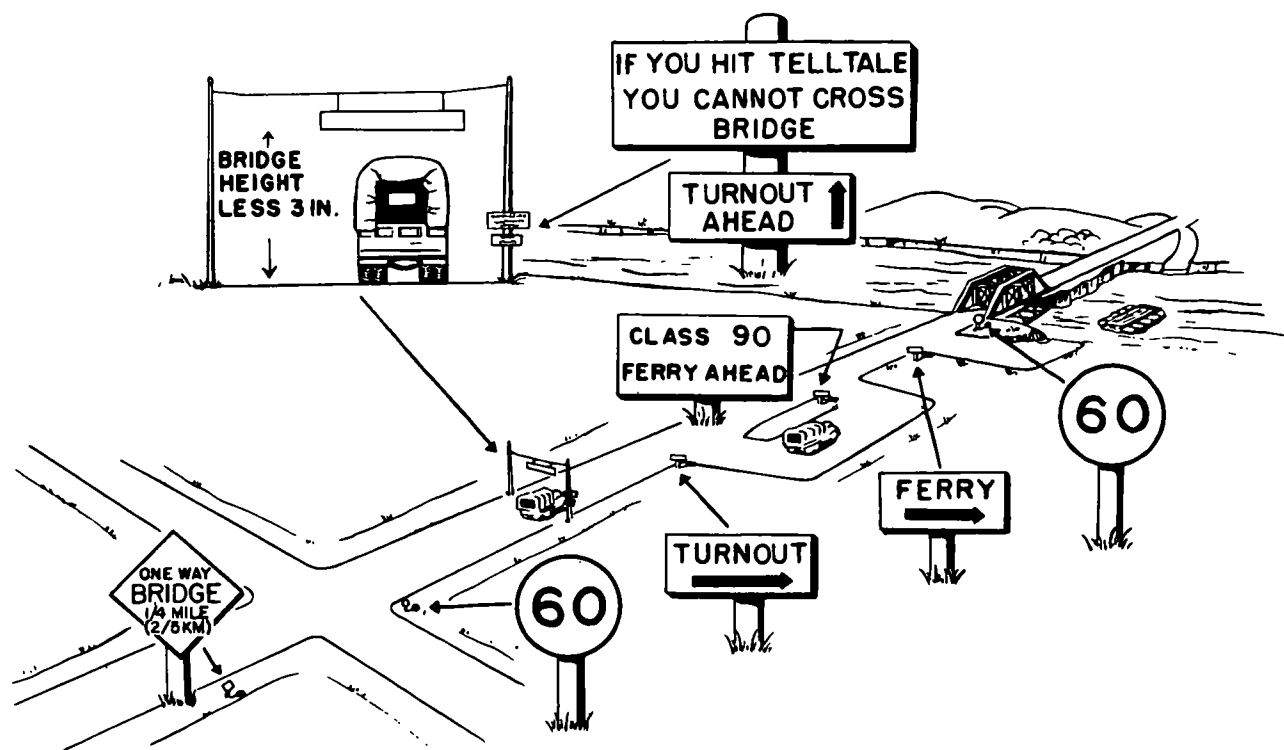


Figure 3-10. Typical arrangement of road-guide information and single-lane bridge-class signs.

3-32. Bridge and Vehicle Weight Classification

a. Posting Bridges. Every military bridge is posted with a number indicating the highest vehicle weight class that can cross safely. Vehicles of higher weight class are barred except for special crossings; for example, reduced speed or limited number of vehicles. Fixed bridges may also be marked with the length in feet of the span to which the posted capacity applies.

b. Marking Vehicles. Self-propelled vehicles in class 3 or higher and towed vehicles in

class 1 or higher are marked to indicate the class, except that prime movers are marked with either their own class or the class of the normal combination of prime mover and trailer or semitrailer. Markings on the front of the trucks should be on the right front, on or above the bumper, but below the driver's vision. Examples of vehicle marking are shown in figure 3-11. Weight classifications listings of vehicles are given in FM 5-36.

3-33. Basic March Formulas

a. General. There are three basic march factors: distance (*D*), rate (*R*), and time (*T*).

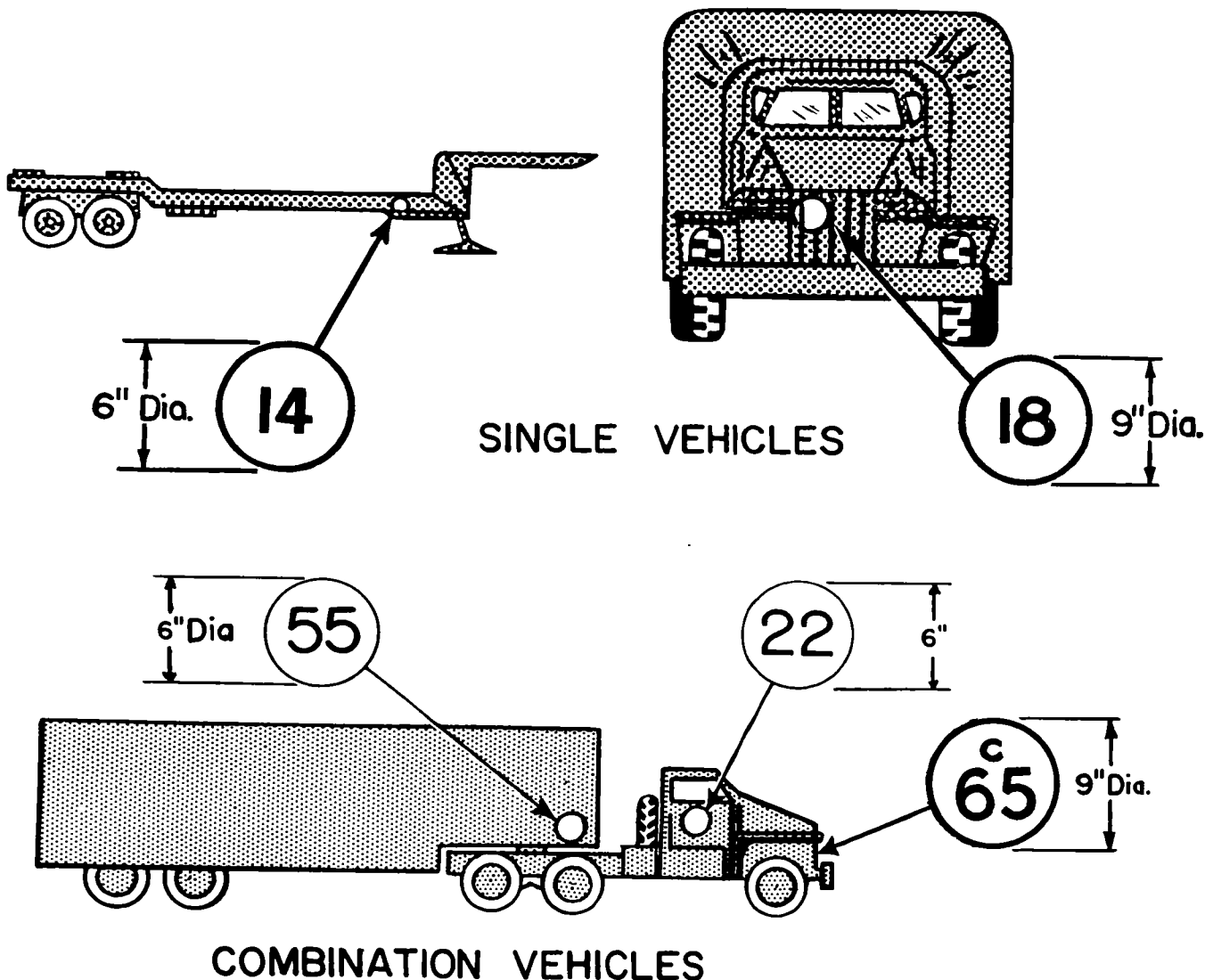


Figure 3-11. Vehicle weight classification marking.

When two are known, the third can be found by using the formula below. Corresponding units of measure must be used throughout.

$$R = \frac{D}{T} T = \frac{D}{R} D = RT$$

b. Rate Factors.

$$\text{Rate (yards per minute)} = \frac{\text{length (yards)}}{\text{pass time (minutes)}}$$

$$\text{Rate (meters per minute)} = \frac{\text{length (meters)}}{\text{pass time (minutes)}}$$

$$\text{Rate (miles in the hour (mih))} = \frac{\text{road distance (miles)}}{\text{time distance (hours)}}$$

$$\begin{aligned} \text{Rate (kilometers in the hour (kmih))} &= \frac{\text{Road distance (kilometers)}}{\text{time distance (hours)}} \\ &= \frac{\text{Road distance (kilometers)}}{\text{time distance (hours)}} \end{aligned}$$

c. Time Factors.

$$\begin{aligned} \text{Pass time (minutes)} &= \frac{\text{length (yards)}}{\text{rate (yards per minute)}} \\ &= \frac{\text{length (meters)}}{\text{rate (meters per minute)}} \end{aligned}$$

$$\begin{aligned} \text{Time lead (minutes)} &= \frac{\text{lead (yards)}}{\text{rate (yards per minute)}} \\ &= \frac{\text{lead (meters)}}{\text{rate (meters per minute)}} \end{aligned}$$

$$\begin{aligned} \text{Time gap (minutes)} &= \frac{\text{gap (yards)}}{\text{rate (yards per minute)}} \\ &= \frac{\text{gap (meters)}}{\text{rate (meters per minute)}} \end{aligned}$$

$$\begin{aligned} \text{Time space (hours)} &= \frac{\text{road space (miles)}}{\text{rate (mih)}} \\ &= \frac{\text{road space (kilometers)}}{\text{rate (kmih)}} \end{aligned}$$

$$\begin{aligned} \text{Pass time (hours)} &= \frac{\text{road distance (miles)}}{\text{rate (mih)}} \\ &= \frac{\text{road distance kilometers}}{\text{rate (kmih)}} \end{aligned}$$

d. Distance Factors.

$$\text{Length (yards)} = \text{rate (yards per minute)} \times \text{pass time (minutes)}$$

$$\text{Length (meters)} = \text{rate (meters per minute)} \times \text{pass time (minutes)}$$

$$\text{Lead (yards)} = \text{rate (yards per minute)} \times \text{time lead (minutes)}$$

$$\text{Lead (meters)} = \text{rate (meters per minute)} \times \text{time lead (minutes)}$$

$$\text{Gap (yards)} = \text{rate (yards per minute)} \times \text{time gap (minutes)}$$

$$\text{Gap (meters)} = \text{rate (meters per minute)} \times \text{time gap (minutes)}$$

$$\text{Road space (miles)} = \text{rates (mih)} \times \text{time space (hours)}$$

$$\text{Road space (kilometers)} = \text{rate (kmih)} \times \text{time space (hours)}$$

$$\text{Road distance (miles)} = \text{rate (mih)} \times \text{time distance (hours)}$$

$$\text{Road distance (kilometers)} = \text{rate (kmih)} \times \text{time distance (hours)}$$

e. Time-Distance Factors (Fig. 3-12). When the speed in miles or kilometers per hour is known, the time in minutes or the distance in miles or kilometers traveled can be quickly determined from a time-distance graph (fig. 3-13). For example, if a convoy moves at a speed of 15 miles per hour (24.14 kmph) for a 2-hour period, the distance traveled can be determined by—

(1) Locating the oblique line marked 15 mph (24.14 kmph).

(2) Locating the horizontal line, extending from the left margin, representing the 2 hours traveled.

(3) Determining the point at which these two lines intersect and reading the distance in miles or kilometers from scale along the bottom (miles) or top (kilometers) margin of the graph. For this example, the distance traveled would be 30 miles (48.27 km).

f. Conversions.

(1) The following factors may be converted into distance or rate by arithmetic:

$$\text{Length} + \text{gap} = \text{lead}$$

$$\text{Pass time (time length)} + \text{time gap} = \text{time lead}$$

$$\text{Distance (miles)} \times 1,760 = \text{distance (yards)}$$

$$\text{Distance (kilometers)} \times 1,000 = \text{distance (meters)}$$

$$\text{Time (hours)} \times 60 = \text{(minutes)}$$

$$\text{Rate (mih)} \times 30 = \text{approximate yards per minute}$$

$$\text{Rate (kmih)} \times 17 = \text{approximate meters per minute}$$

(2) These factors are substituted in the basic formulas in *a* through *d* above.

For example:

$$\text{Pass time (minutes)} = \frac{\text{miles} \times 1,760}{\text{mih} \times 30} = \frac{\text{kilometers} \times 1,000}{\text{kmih} \times 17}$$

$$\text{Speed (yards per minute)} = \frac{\text{miles} \times 1,760}{\text{hours} \times 60}$$

$$\text{Speed (meters per minute)} = \frac{\text{kilometers} \times 1,000}{\text{hours} \times 60}$$

3-34. Basic Lengths

The length of any column or element of a column is the length of roadway which it occupies, measured from front to rear, inclu-

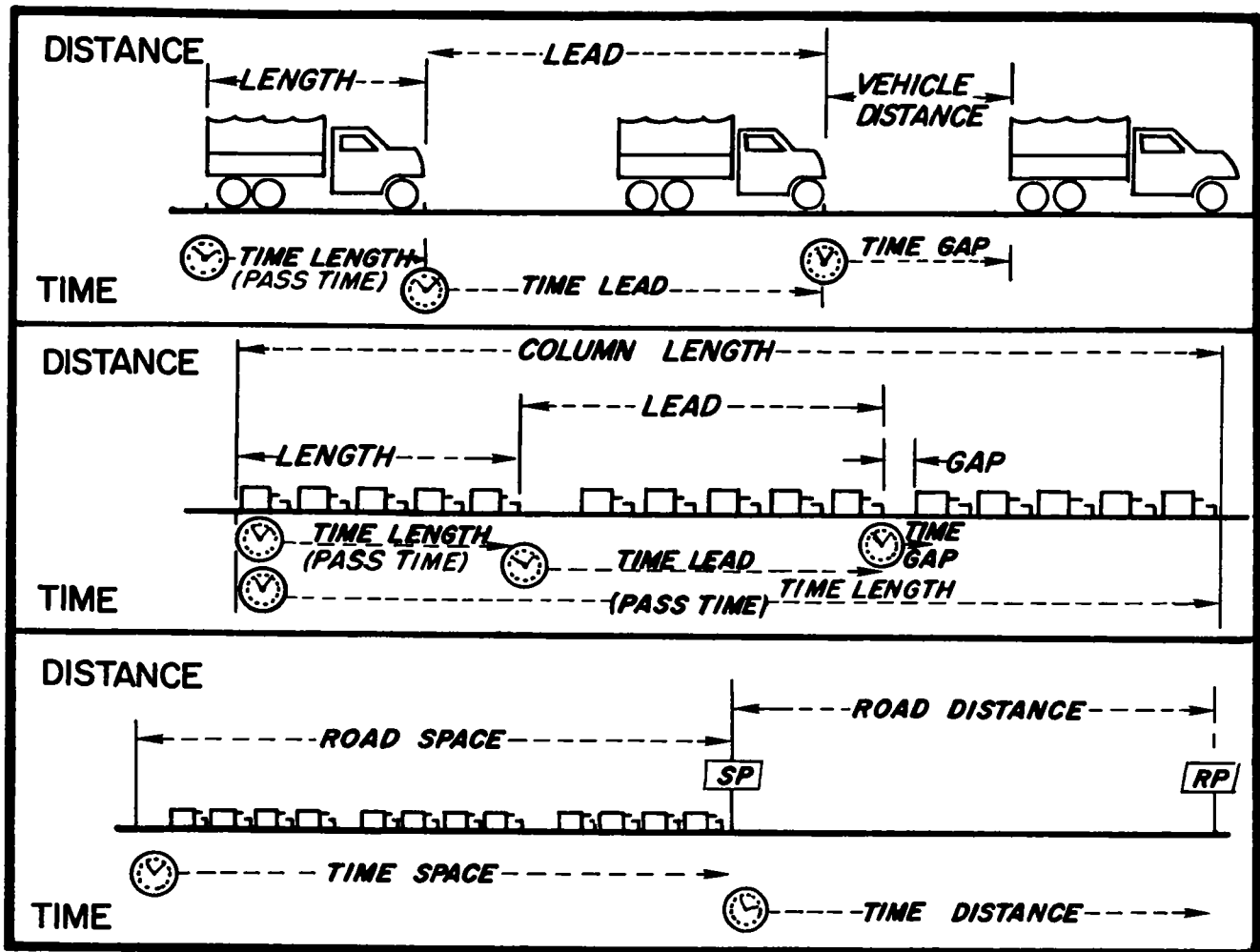


Figure 3-12. Space and time factors.

sive. For planning purposes, the average length of one motor transport vehicle is 10 yards (approximately 9 meters).

3-35. Road-Movement Graph

a. Definition. A road-movement graph (fig. 3-14) is a time-space diagram used in controlling both foot and road marches and in preparing or checking road-movement tables. The graph helps the planner to foresee possible conflicts and discrepancies in planning.

b. Uses. Road-movement graphs may be used to indicate—

(1) Position of various mixed traffic on a route at a particular time.

(2) Scheduled passing of various elements of traffic at a particular point.

(3) Conflicts between various elements of traffic at junctions, intersections, bridges, and defiles.

(4) Deviations of columns from prescribed schedule.

(5) Reversing directions of march, either by simultaneous turn of all elements of a column or by circling about.

(6) Two-way traffic over a route and alternating traffic through defiles.

(7) Variations in actual running speeds and in the traffic flow and traffic density of a route.

c. Construction.

(1) Analyze the route on the map. Note important points, such as cities, towns, road junctions, bottlenecks, etc., to be passed through

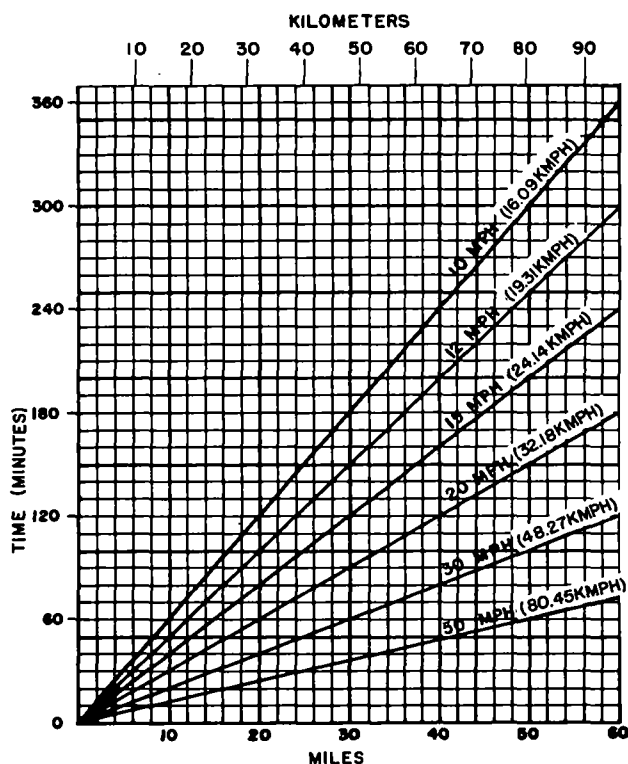


Figure 3-13. Time-distance graph.

and the distance between major points along the route.

(2) Select graph paper with enough squares to plot distance and time involved. Across bottom left to right, place scale of time. In left margin, from bottom to top, place scale of distance.

(3) If the origin and destination, rate of march, and time of departure of a movement are known, schedule the head of the column as follows:

(a) Assume that a unit is to march from Mount Royal (25 miles (40.2 km)) on the vertical scale, leaving at 0700 hours and proceeding at 15 miles in the hour (24.1 km/h) to a point 5 miles (7.4 km) beyond Tavistock. The distance is 60 miles (96.5 km). At 15 miles in the hour, it will take 4 hours to cover the 60 miles.

(b) Place a dot at the point where the line representing the place of departure (Mount Royal) at 25 miles (40.2 km) on the vertical scale intersects the line representing the hour

of departure (0700 hours on horizontal scale).

(c) Place a second dot at the point where the line representing the destination (5 miles past Tavistock at the 85-mile (136.7 km) mark on the vertical scale) intersects that of hour of scheduled arrival of the head of the column at the destination (1100 hours on the horizontal scale or 0700 plus 4 hours).

(4) Unless the unit is very small, usually it is desirable to show the schedule of the tail of the column as well as the head. After charting the schedule of the head, schedule the tail if the time length of the column is known or can be computed. Assuming that the time length of the column, including extra time allowance, is 30 minutes, a line drawn from the point representing the clearance of the column at origin (0730 hr) and at the destination (1130 hr) will be shown the schedule of the tail of the column past all points en route.

(5) To determine what time the column must start to complete the movement and arrive at the destination at a certain hour reverse the above procedure.

d. *Analysis.* Length of column, pass time (time length), rate of march, and other factors may be determined from the road-movement graph as follows:

(1) *Length of column.* A vertical line connecting the head and tail lines, measured by the scale of miles or kilometers, will show the planned length of the column on the road at the prescribed rate of march at any hour during the movement, provided that the extra time allowance, if any, converted to distance is subtracted from the measurement.

Example: When the head of the column is at Stevens (45 miles (72.4 km) on vertical scale), the tail will be at approximately the 38-mile (61.1 km) mark.

(2) *Pass time (time length).* A horizontal line connecting the head and tail lines, measured by the scale of hours, will show the planned pass time of the column as it passes any point on the road.

Example: If the head of the column arrives at Tavistock at 1040 hours, the tail will not clear that point until half an hour later, at 1110 hours.

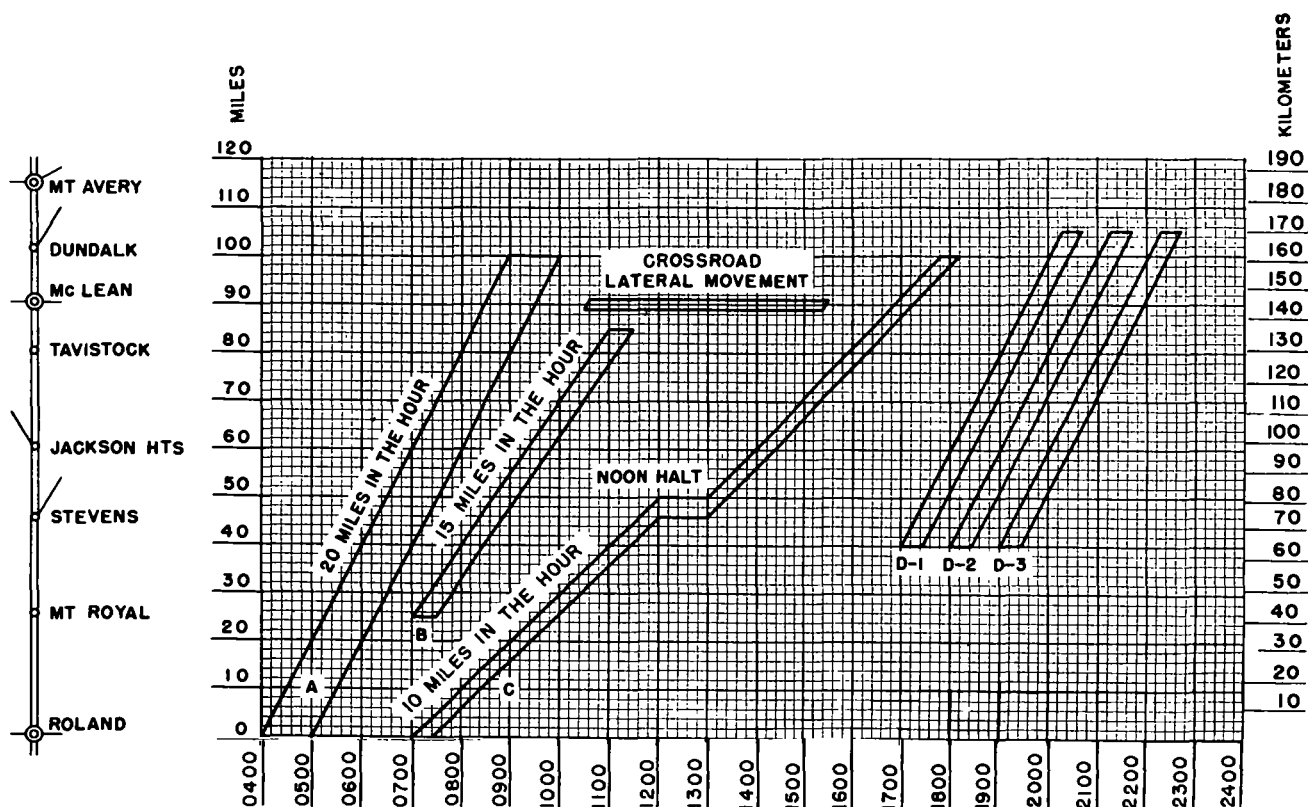


Figure 3-14. Road-movement graph.

(3) *Rate of march.* The diagonal line of the graph indicates the rate of march.

Example: The distance (mile or kilometer scale) between the intersection of the diagonal line with any two vertical lines spanning a 1-hour period (time scale) indicates the distance in that hour.

e. Multiple Movements.

(1) A number of serials or columns over the same route can be scheduled by using a road-movement graph. The commander of a large unit or the highway regulation officer can keep accurate records of the location of each serial by having information sent to him as each serial reaches or clears highway regulation points along the route of march. This information is indicated by filling in the space between the lines representing the scheduled head and tail of each column with color or tape. This enables the headquarters to see at a glance the location of each serial, to follow the progress of each movement, to correct situations which may cause congestion and

delay, and to know where each serial can be reached in order to issue new orders if necessary.

(2) Colored pencils, crayons, ink, or adhesive tape may be used to indicate various schedules and the relative priority of movements or to plot movements in progress. For example, the head and tail schedule may be outlined by black lines, progress of each serial may be filled in with green, and failure to adhere to the schedule may be shown in red.

(3) Figure 3-15 shows the plotted progress of serials scheduled in figure 3-14. Note the changes and adjustments in schedules that had to be made. This is what happened—

(a) *Serial A.* Went through as scheduled.

(b) *Serial B.* Change in orders required that serial B continue on to Dundalk. It continued on schedule, and the head of the column arrived at its new destination at noon.

(c) *Lateral movement.* Because of a change of orders for serial B, arrangements

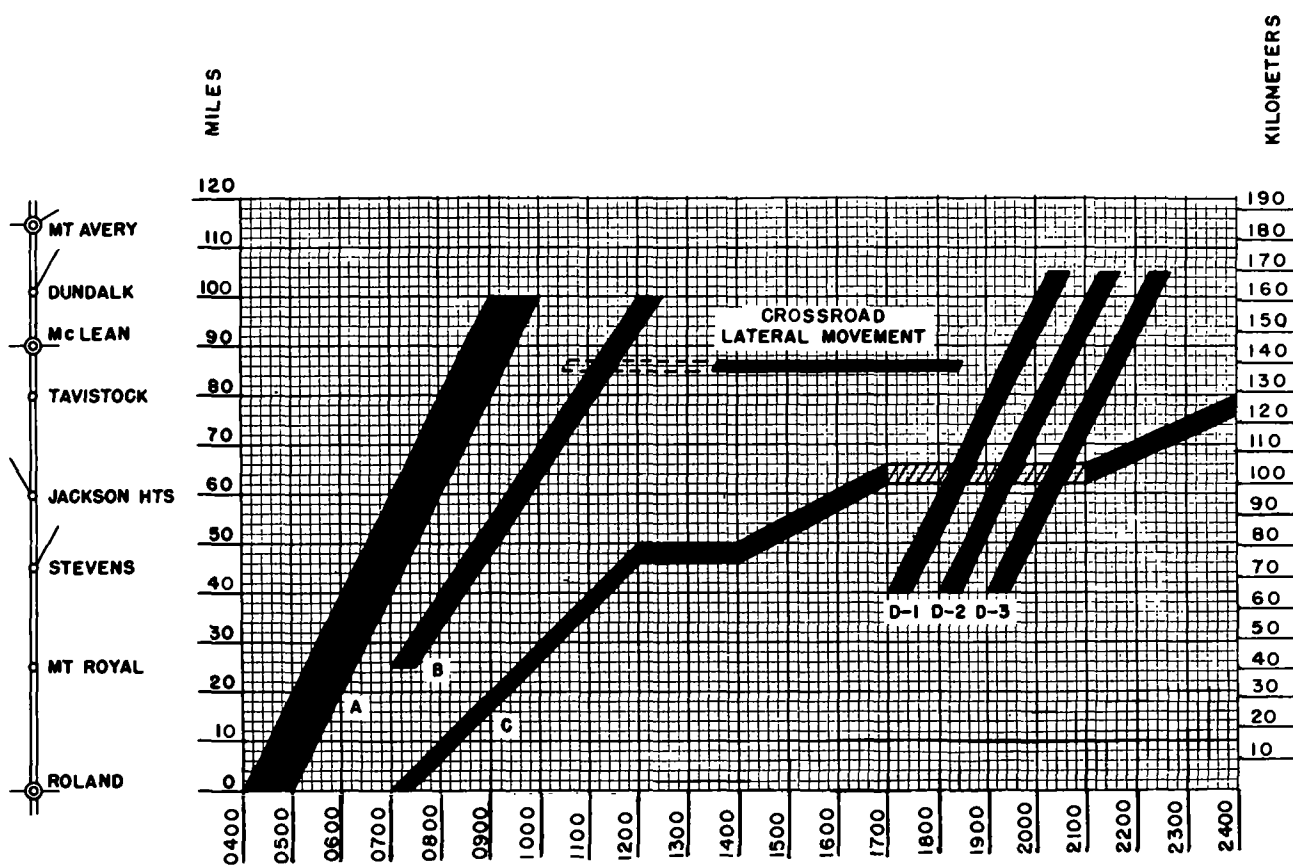


Figure 3-15. Deviations from schedules.

had to be made to hold the lateral movement at McLean. It made its noon halt and crossed the route 3 hours behind its original schedule, not clearing until 1830 hours.

(d) *Serial C.* At 1200 hours it became obvious that if serial C continued on schedule, it would conflict with the delayed lateral movement at about 1730 hours. Serial C also had lost priority, because of the arrival of serial B at Dundalk with critically needed supplies. Therefore, serial C was halted for 2 hours (from 1200 to 1400 hours). It continued at a slower rate of march until 1700 hours, when it was halted again to let serial D pass.

(e) *Serial D (D-1, D-2, D-3).* All elements went through on schedule.

3-36. Traffic Density and Traffic Flow

a. Traffic density is the average number of vehicles that occupy 1 mile or 1 kilometer of road space. It is expressed as vehicles per mile (vpm) or vehicles per kilometer (vpk)

as appropriate. This factor is based upon an average vehicle length and a constant vehicle gap.

b. Traffic flow is the total number of vehicles which will pass a designated point along a road or route of march in a given period of time, normally an hour. Traffic flow is expressed as vehicles per hour (vph). This is based upon a constant operating speed as well as an average vehicle length and a constant vehicle gap. With a constant vehicle gap, traffic flow increases as speed increases and decreases as speed is reduced.

c. Any traffic density desired for dispersion or for maintaining the maximum capacity of a route may be arrived by selecting an appropriate intervehicular gap and using the following formulas:

$$\frac{1 \text{ mile in yards}}{\text{Desired intervehicular gap in yards} + \text{avg length of 1 veh}} = \text{vehicles per mile}$$

$$\frac{1 \text{ kilometer in meters}}{\text{Desired intervehicular gap in meters} + \text{avg length of 1 veh}} = \text{vehicles per kilometer}$$

Example: If vehicles are dispersed every 100 yards (91.4 m), density is—

$$\frac{1,760}{100 + 10} = 16 \text{ vehicles per mile}$$

$$\frac{1,000}{91.4 + 9} = 10 \text{ vehicles per kilometer}$$

d. When the speed and speedometer multiplier are known, traffic density may be determined by using the following formulas:

$$\frac{1 \text{ mile in yards}}{(\text{Speed in mph} \times \text{speedometer multiplier}) + \text{avg length of 1 veh}} = \text{vehicles per mile}$$

$$\frac{1 \text{ kilometer in meters}}{(\text{Speed in kmph} \times \text{speedometer multiplier}) + \text{avg length of 1 veh}} = \text{vehicles per kilometer}$$

Example: If the speed of a column is 20 miles per hour (32.19 kilometers per hour) and a speedometer multiplier of 2 for miles or 1.2 for kilometers is used, traffic density is—

$$\frac{1,760}{(20 \times 2) + 10} = 35 \text{ vehicles per mile}$$

$$\frac{1,000}{(32.19 \times 1.2) + 9} = 21 \text{ vehicles per kilometer}$$

e. At a constant speed, traffic density can also be determined by counting the number of vehicles passing a given point in a period of time. Use the following formulas:

$$\frac{\text{Vehicles per hour passing point}}{\text{Speed in miles per hour}} = \text{vehicles per mile}$$

$$\frac{\text{Vehicles per hour passing point}}{\text{Speed in kilometers per hour}} = \text{vehicles per kilometer}$$

Example: If 500 vehicles pass a given point in 1½-hour at 20 miles per hour (32.19 kilometers per hour), traffic density is determined as follows:

$$500 \text{ vehicles per } \frac{1}{2} \text{ hour} = 1,000 \text{ vehicles per hour}$$

$$\frac{1,000}{20} = 50 \text{ vehicles per mile}$$

$$\frac{1,000}{32.19} = 31 \text{ vehicles per kilometer}$$

f. Traffic flow may be determined by using the following formula:

$$\frac{\text{Traffic speed (mph)} \times 5,280 \text{ (feet in 1 mile)}}{\text{Vehicle lead (from front of first to front to following vehicle)}} = \text{traffic flow}$$

Example:

$$\frac{30 \times 5,280}{88} = 1,800 \text{ vehicles per hour}$$

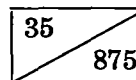
g. Table 3-5 provides the motor transport planner and/or operator with a convenient means of determining either or both, the traffic flow and the traffic density for planned or actual movements operating over the road at various speeds and gaps.

(1) To use table 3-5 to determine either traffic flow or traffic density, two operating factors must be known; these factors are vehicle gap and operating speed for the operation under consideration. These factors are applied by—

(a) Reading across the bottom scale to the column indicating the appropriate vehicle gap.

(b) Reading up that vehicle gap column to the block opposite the appropriate speed. This block at the intersection of these known data provides the desired answer concerning traffic density and traffic flow.

Example No. 1: Assume that a convoy is to move over a road with a vehicle gap of 40 yards and at a speed of 25 miles per hour (mph). By reading across the bottom scale (vehicle gap) to the 40-yard column, and then reading up that column to where it intersects the horizontal scale (speed) at 25 mph, you come to a box that reads



The figure in the upper diagonal indicates traffic density (number of vehicles per mile of roadway) for this operation; the figure in the lower diagonal indicates traffic flow (the number of vehicles that will pass a given point in 1 hour for this operation).

(2) The same procedure as outlined in (1) above is followed when vehicle gap and speed are expressed in the metric system (meters and kilometers). However, the traffic density figures on the chart indicate *vehicles per mile* and this must be converted to *vehicles per kilometer*; this is done by multiplying the

Table 3-5. Vehicle Traffic Flow and Density

MPH	KMPH (APPX)																			
50	80									29	27	25	23	22	21	20	19	18	17	16
										1450	1350	1250	1150	1100	1050	1000	950	900	850	800
45	72							35	32	29	27	25	23	22	21	20	19	18	17	16
								1575	1440	1305	1215	1125	1035	990	945	900	855	800	765	720
40	64							35	32	29	27	25	23	22	21	20	19	18	17	16
								1400	1280	1160	1080	1000	920	880	840	800	760	720	680	640
35	56				44	39	35	32	29	27	25	23	22	21	20	19	18	17	16	
					1540	1365	1225	1120	1015	945	875	805	770	735	700	665	630	595	560	
30	48		70	58	50	44	39	35	32	29	27	25	23	22	21	20	19	18	17	16
			2100	1740	1500	1320	1170	1050	960	870	810	750	690	660	630	600	570	540	510	480
25	40	88	70	58	50	44	39	35	32	29	27	25	23	22	21	20	19	18	17	16
		2200	1750	1450	1250	1100	975	875	800	725	675	625	575	550	525	500	475	450	425	400
20	32	88	70	58	50	44	39	35	32	29	27	25	23	22	21	20	19	18	17	16
		1760	1400	1160	1000	880	780	700	640	580	540	500	460	440	420	400	380	360	340	320
15	24	88	70	58	50	44	39	35	32	29	27	25	23	22	21	20	19	18	17	16
		1320	1050	870	750	660	585	525	480	435	405	375	345	330	315	300	285	270	255	240
10	16	88	70	58	50	44	39	35	32	29	27	25	23	22	21	20	19	18	17	16
		880	700	580	500	440	390	350	320	290	270	250	230	220	210	200	190	180	170	160
5	8	88	70	58	50	44	39	35	32	29	27	25	23	22	21	20	19	18	17	16
		440	350	290	250	220	195	175	160	145	135	125	115	110	105	100	95	90	85	80
YARDS		10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
METERS (APPX)		9	14	18	23	27	32	37	41	46	50	55	59	64	69	73	78	82	87	91

Notes:

1. Figures in upper diagonals of boxes denote **TRAFFIC DENSITY**; figures in lower diagonals of boxes denote **TRAFFIC FLOW**.
2. Traffic density figures represent **VEHICLES PER MILE (VPM)**; to convert to **VEHICLES PER KILOMETER (VPK)** multiply by .62

given traffic density figure by .62. No adjustment is required for the traffic flow since this is based on a constant time factor of 1 hour and on a given point along the route or road. *Example No. 2:* Assume that a convoy is to move over a road with a vehicle gap of 32 meters and at a speed of 32 kilometers per hour (kmph). By reading across the bottom scale (vehicle gap) to the 32-meter column, and then reading up that column to where it intersects the horizontal scale (speed at 32 kmph), you come to a box that reads

39
780

The figure in the upper diagonal indicates traffic density (number of vehicles per *mile* of roadway) for this move. To determine the number of vehicles per *kilometer* of roadway, the traffic density is multiplied by .62—if the answer contains a fraction of .50 or greater, the answer is raised to the next higher full number. For this example, $39 \times .62 = 24.18$ or 24 vehicles per kilometer. Since the figure in the lower diagonal represents traffic flow and is based on a time factor, no adjustment is required for this figure.

(3) Table 3-5 has other applications—for example, it may be used by the motor transport planner and/or operator to determine appropriate vehicle gaps and operating speeds compatible with restrictions imposed on an operation with which he is concerned. Thus, if instructions from higher headquarters or if operating conditions dictate that only a given number of vehicles per hour arrive at a designated point, such as a critical road junction, a river crossing point, or a loading or unloading point (example 3) or that traffic density on a certain route be limited to a specific number of vehicles per mile (example 3), these restrictive figures may be correlated with those contained in the table and suitable operating gaps and speeds may be determined.

Example No. 3: Assume that the planner or operator is informed by higher headquarters that forward moving traffic passing a critical point on a route is restrained to no more than 400 vehicles per hour and he is to maintain

that flow as nearly as possible. By scanning the traffic flow figures of the table he can determine that there are several speed and gap combinations which will meet this restriction (for example, 10 mph at a 35-yard vehicle gap—390 vph; 15 mph at 60-yard vehicle gap—375 vph; 20 mph at 80-yard vehicle—400 vph; 25 mph at 100-yard vehicle gap—400 vph). Based on this guidance and considering other operational factors involved, he can determine a suitable speed and gap for his operation.

Example No. 4: Assume that the planner or operator is informed by higher headquarters that traffic density over a given route is restricted to no more than 30 vehicles per mile and no less than 25 vehicles per mile and he is to maintain this density as nearly as possible. By scanning the traffic density figures of the table, he can determine the vehicle gaps which will meet this restriction. (At a vehicle gap of 50 yards, traffic density is 29 vehicles per mile; at a vehicle gap of 55 yards, traffic density is 27 vehicles per mile; and at a gap of 60 yards, traffic density is 25 vehicles per mile.) This information provides guidance to him in determining the vehicle gap for the operation with which he is involved.

(4) Although this table is set up in speed increments of 5 miles or 8 kilometers per hour, traffic flows for intermediate speeds may be determined if desired. This is done by dividing the difference in traffic flow between two consecutive speeds by either 5, for miles per hour (example No. 5), or 8, for kilometers per hour (example No. 6). The result is the number of vehicles to be added to the lesser of the traffic flow figures used, for each additional mile or kilometer per hour desired above the lesser figure. (Carry any fractions through third step, then raise any fraction in result of third step to next higher number.)

Example No. 5: Assume that a planner or operator wishes to determine the traffic flow for a motor move to be conducted at a speed of 23 mph and at a vehicle gap of 50 yards between vehicles. He must—

First, determine the difference in traffic flow between 20 mph and 25 mph at a vehicle gap of 50 yards:

$$\begin{array}{r} 725 \text{ (vph at 25 mph)} \\ -580 \text{ (vph at 20 mph)} \\ \hline 145 \end{array}$$

Then, divide the result by 5 (the numerical difference between 20 and 25 mph) to determine the traffic flow for 1-mile-per-hour steps between these speeds.

$$\frac{145}{5}=29$$

Then, multiply this result by 3 (numerical difference between 20 and 23 mph).

$$\begin{array}{r} 29 \\ \times 3 \\ \hline 87 \end{array}$$

Finally, add this resulting figure to the traffic flow indicated for 20 mph to determine the traffic flow at 23 mph.

$$\begin{array}{r} 580 \\ +87 \\ \hline 667 \text{ (vph at 23 mph)} \end{array}$$

Example No. 6: Assume that a planner or operator wishes to determine the traffic flow for a motor move to be operated at a speed of 45 kmph and at a vehicle gap of 64 meters between vehicles. He must—

First, determine the difference in traffic flow between 40 kmph and 48 kmph at a vehicle gap of 64 meters.

$$\begin{array}{r} 660 \text{ (vph at 48 kmph)} \\ -550 \text{ (vph at 40 kmph)} \\ \hline 110 \end{array}$$

Then, divide this result by 8 (the numerical difference between 40 and 48 kmph) to determine the traffic flow for 1-kilometer-per-hour steps between these speeds.

$$\frac{110}{8}=13.6$$

Then, multiply this result by 5 (the numerical difference between 40 and 45 kmph).

$$\begin{array}{r} 13.6 \\ \times 5 \\ \hline 68 \end{array}$$

Finally, add this resulting figure to the traffic flow indicated for 40 kmph to determine the traffic flow at 45 kmph.

$$\begin{array}{r} 550 \\ +68 \\ \hline 618 \text{ (vph at 45 kmph)} \end{array}$$

3-37. Road-Movement Table

a. A road-movement table is a convenient means of transmitting to subordinates information about schedules and other essential details. This is particularly so if the inclusion of such details in the body of the operation order would tend to complicate it or make it unduly long. Tables frequently require a wider distribution than normal operation orders because copies are issued to convoy operating personnel, traffic regulating personnel, and traffic control posts. For security reasons, it may not be desirable to include dates or locations. Security classification is given in accordance with contents of the table; it is not necessarily the same as that of the operation order. If the table is issued by itself and not as an annex to a more detailed operation or administrative order, it must be signed and/or authenticated in the same manner as other orders.

b. The beginning of the table includes general information common to two or more serials, e.g., security classification, maps, average speed, traffic density, halts, main routes to the start and release points, and information about other critical points. Information concerning the routes and critical points is normally described by grid references, code words, etc., and, if necessary, may be numbered or lettered for ease of reference to the columns in the table. The remainder of the table includes information concerning each individual serial and is arranged in tabular form. Table 3-6 is a sample road movement table.

3-38. Strip Map

A strip map (fig. 3-16) may be published as an annex to an operation order. When a strip map is used, its details should correspond to the data in the road movement table, and it should be distributed to the lowest practical level.

Table 3-6. Road Movement Table.

(SECURITY CLASSIFICATION)

Table 3-6. Sample Road Movement Table

 Annex _____ to _____ (Formation/Unit)
 Operation Order No. _____
 Dated _____

Mapa _____

1. Average speed
 2. Traffic density
 3. Halts
4. Route (between start points and release points may be indicated by code--red, green, etc.)
5. Critical points¹
 a. Start points
 b. Release points
 c. Other critical points
6. Main routes to start points
 7. Main routes from release points
- These routes and points may be described by grid references, code words, etc., and if necessary, numbered or lettered for ease of reference in the columns below.

Serial ² (a)	Date (b)	Unit formation (c)	No. of vehicles (d)	Load class of heaviest vehicles (e)	From (f)	To (g)	Route (h)	Route to start point (i)	Critical points ¹			Route from release point (n)	Remarks ³ (o)
									Ref (k)	Due (hrs) (l)	Clear (hrs) (m)		
1	23 Oct	46 Trans Co 51 Trans Co (Lt Trk)	90	21	Marseille	Montelimar	N 113 N 538 N 7	City	Marseille Salon Plan-Orgon Avignon Orange Pierralatte Montelimar	0800 0935 1016 1059 1150 1250 1330	0818 0935 1034 1117 1208 1308 1346	N 540	Return to Marseille immediately after unloading as Serial 1A.
2	23 Oct	67 Trans Co 70 Trans Co (Lt Trk)	120	21	Marseille	Montelimar	N 113 N 538 N 7	City	Marseille Salon Plan-Orgon Avignon Orange Pierralatte Montelimar	0820 1003 1044 1127 1218 1318 1358	0851 1026 1107 1150 1241 1341 1421	N 540	Relieved from attachment upon closing in Marseille.
3	23 Oct	89 Trans Co 90 Trans Co (Med Trk)	115	21	Marseille	Montelimar	N 113 N 538 N 7	N 8	Marseille Salon Plan-Orgon Avignon Orange Pierralatte Montelimar	0901 1036 1117 1201 1426 1526 1605	0925 1100 1141 1359 1450 1550 1629	N 540	Halt in place south of Avignon. Resume march at 1335 hours.

¹ Critical points are selected points along the route used for reference in giving instruction. These points include start point, release point, and other points along the route where interference with the movement may occur or where timing is critical.

² A movement serial is an element or group of elements within a series and in this table has a numerical designation for convenience in planning, scheduling, or control of movement.

³ Information which is common to two or more serials will be given in the beginning of the table, items 1-7.

(SECURITY CLASSIFICATION)

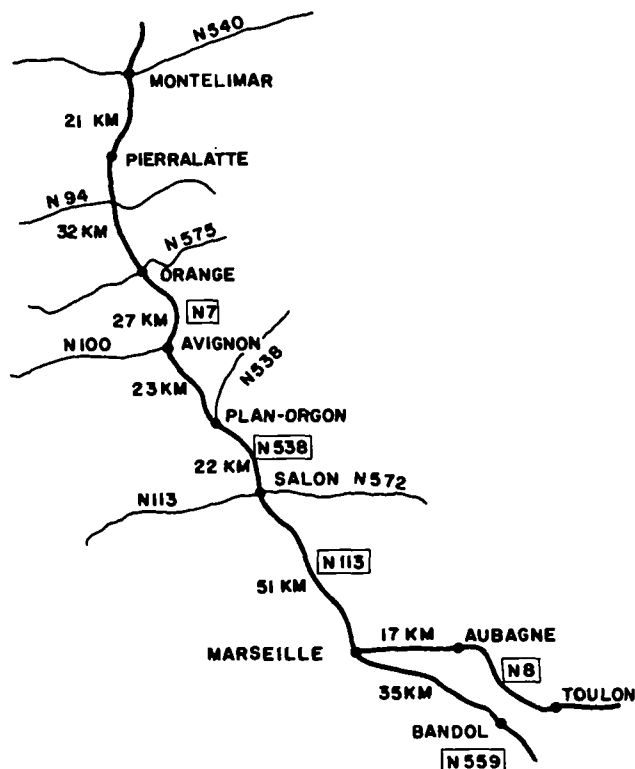


Figure 3-16. Sample strip map.

Section IV. MOTOR TRANSPORT PLANNING

3-39. General Planning Factors

a. Motor transport planning, particularly in its earliest stages, must often be based on broad planning factors and assumptions. However, because of the varied services performed, the type of loads carried, and the varied terrain features over which motor transport operations are conducted, general planning factors should be used with caution and only in the absence of specific data on the local situation.

b. When specific data is not available, the following factors are used in motor transport planning to compute vehicle and truck company requirements.

(1) Average number of assigned task vehicles not in maintenance and therefore available for daily operations:

Operational short range—83 percent (maximum sustained effort; used only for all-out effort, and then only for

periods of less than 30 days). Long range planning—75 percent.

(2) Anticipated payload per vehicle:

Off-road—rated cargo capacity of vehicle (except tank semitrailers which are rated at 3,000-gallon capacity for off-road operations).

Highway—rated cargo capacity plus 50 percent for trailers or semitrailers and 100 percent for tactical wheeled vehicles (except tank semitrailers which have a maximum load capacity of 5,000 gallons).

(3) Daily round trips that a vehicle averages (these vary with running time and delay times):

Line haul—one per operating shift.

Local haul—four per day (2 per operating shift).

(4) One-way distance cargo is to be

hauled, from which round trip mileage may be computed:

Line haul—90 miles one way per operating shift.

Local haul—15 miles one way per trip.

(5) Average number of miles covered in an hour, including short halts during the period of movement:

Poor roads—10 miles in the hour.

Good roads—20 miles in the hour

Note. Under road conditions, not only surface must be considered but also terrain, whether, and hostile activity which may affect rate of march.

(6) Turnaround time—time consumed round-trip movement, including delays.

(7) Delay—time consumed in loading and unloading and/or relay time in line haul relay operations. (Time for halts and delays en route, such as mess halts, ferrying operations, etc., which can be anticipated but are not included in the rate of march, must be included in delay time.)

Straight trucks—2.5 hours loading and unloading time per round trip (straight haul).

Semitrailers—2.5 hours loading and unloading time per round trip (straight haul).

Truck tractors in semitrailer relay operations—1 hour per relay (round trip per line-haul leg).

(8) Number of hours per day in which vehicles with drivers are normally employed—One shift—10 hours.

→ Round-the-clock (two shifts)—20 hours.

(9) Unit lift and daily lift—unit lift is the amount of cargo a truck company can move at one time; daily lift is that which it can move in a day, making a number of trips.

(10) Ton miles and passenger miles—the product of the number of tons or passengers times the number of miles moved.

3-40. Unit and Vehicle Capability Estimates

a. Unit Capability. For planning purposes and in the absence of other specific operational data, motor transport unit capability estimates, based on tables of organization and equipment (TOE) capabilities, are shown in tables 3-7 through 3-10.

Table 3-7. Unit Tonnage Capability Estimates—
Local Hauls

(Vehicle availability times average tons per vehicle times trips per day = short ton capability per day.)

Light truck company		
(2½-ton truck) -----	45×4×4=	720
Light truck company		
(5-ton truck) -----	45×6×4=	1,080
Medium truck company (cargo)		
12-ton stake and platform ---	45×12×4=	2,160
Medium truck company (petroleum)		
(5,000-gallon tanker) -----	45×5,000×4=	900,000 gal.
Medium truck company (reefer)		
(7½-ton reefer van) -----	45×6×4=	1,080
Heavy truck company		
(50-ton semitrailer) -----	18×40×4=	2,880
Light-medium truck company:		
2½-ton truck -----	45×4×4=	720
12-ton stake and platform ---	8×12×4=	384
	Total=	1,104

Table 3-8. Unit Passenger Capability Estimates—
Local Hauls

(Vehicle availability times passengers per vehicle times trips per day = passenger capability per day.)

Light truck company		
(2½-ton truck) -----	45×20×4=	3,600
Light truck company		
(5-ton truck) -----	45×20×4=	3,600
Medium truck company		
(cargo) ^a -----	45×50×4=	9,000
2½-ton truck -----	45×20×6 ^b =	5,400
12-ton stake and platform ^a -----	8×50×6 ^b =	7,800
	Total=	13,200

^a Recommended for emergency use only; no troop seats provided.
^b Number of trips based on employment of unit in tactical situation (short turnaround times); for general troop movements, planner should plan on four trips per day.

Table 3-9. Unit Tonnage Capability Estimates—
Line Hauls

(Vehicle availability times average tons per vehicle times trips per day = short ton capability per day.)

Light truck company		
(2½-ton truck) -----	45×4×2=	360
Light truck company		
(5-ton truck) -----	45×6×2=	540
Medium truck company (cargo)		
(12-ton stake and platform) --	45×12×2=	1,080
Medium truck company (petroleum)		
(5,000-gallon tanker) -	45×5,000 gal.×2=	450,000 gal.
Medium truck company (reefer)		
(7½-ton reefer van) -----	45×6×2=	540
Heavy truck company		
(50-ton semitrailer) -----	18×40×2=	1,440
Light-medium truck company:		
2½-ton truck -----	45×4×2=	360
12-ton stake and platform ---	8×12×2=	192
	Total=	552

Table 3-10. Unit Passenger Capability Estimates—
Line Hauls

(Vehicle availability times passengers per vehicle times trips per day = passenger capability per day.)

Light truck company	
(2½-ton truck) -----	45×16×2=1,440
Light truck company	
(5-ton truck) -----	45×18×2=1,620
Medium truck company (cargo) ^a ---	45×50×2=4,500
Light-medium truck company:	
2½-ton truck -----	45×20 ^b ×2=1,800
12-ton stake and and platform ^a ----	8×50×2= 800
	Total=2,600

^a Recommended for emergency use only; no troop seats provided.

^b Number of personnel per vehicle based on employment of unit in tactical situation; for general troop movements, planner should recompute using 16 troops per vehicle.

b. Vehicle Capabilities. Vehicle capabilities given in table 3-11 may be used in conjunction with other planning factors.

Table 3-11. Vehicle Payload Capacities for General Planning

Nomenclature	Off-road (tons)	Highway average (tons)	Highway maximum (tona)	Towing capacity (tons)		Passengers ^a	Cargo space
				Highway	Cross- country		
Automobile, sedan, 1t ---	-----	-----	-----	-----	-----	4 ^b	-----
Bus, convertible, 37-pas- senger	-----	-----	-----	-----	-----	37 or 18 litter	-----
Carrier, pers, full-tracked, armd, M59	1½	1½	1½	-----	-----	10	-----
Carrier, pers, full-tracked, armd, M113	-----	-----	-----	-----	-----	11	-----
Stlr, cgo van, 6-ton, 2- wheel, M119	6	9	9	-----	-----	24 ^c	1,020 cu ft
Stlr, shop, van, 6-ton, 2- wheel, M146	6	8	8	-----	-----	-----	1,675 cu ft
Stlr, stake, 6-ton, 2-wheel, M118	6	9	9	-----	-----	24 ^c	1,130 cu ft
Stlr, reefer, 7½-ton, 2- wheel	6 ^d	6	7½	-----	-----	-----	790 cu ft
Stlr, van, 10-ton, 4-wheel	-----	8	10	-----	-----	50 ^c	1,355 cu ft
Stlr, cgo, 12-ton, 4-wheel, M127A1	12	12	18	-----	-----	50 ^c	884 sq ft
Stlr, low-bed, 12-ton, 25 ft	12	16	18	-----	-----	-----	200 sq ft
Stlr, sup van, 12-ton, 4- wheel M129	12 ^d	18	18	-----	-----	50 ^c	1,342 cu ft
Stlr, low-bed, 15-ton, 4- wheel, M172	25	16	25	-----	-----	-----	320 sq ft
Stlr, tk transporter, 50- ton, 8-wheel, M15A2	50 ^d	40	50	-----	-----	-----	-----
Stlr, low-bed, 60-ton, 8- wheel, M162	60	60	60	-----	-----	-----	204 sq ft
Stlr, tk, gas, 5,000-gal, 4- wheel M131A2	3,000 gal. ^d	5,000 gal.	5,000 gal.	-----	-----	-----	-----
Tlr, amph, cgo, ¼-ton, 2- wheel	¼	¾	¾	-----	-----	-----	60 cu ft
Tlr, cgo, ¾-ton, 2-wheel	¾	1¼	1⅞	-----	-----	-----	175 cu ft
Tlr, cgo, 1½-ton, 2-wheel	1½	2¼	2¾	-----	-----	-----	283 cu ft
Tlr, ammo, 2-ton, 2-wheel	2	2	3	-----	-----	-----	-----
Trk, util, ¼-ton, 4×4 ---	0.4	0.4	0.6	1	¾	2	66 cu ft
Trk, cgo, ¾-ton, 4×4 ---	¾	1	1½	2	-----	8	160 cu ft
Trk, cgo, 2½-ton, 6×6 --	2½	4	5	5	3	20 ^e	408 cu ft
Trk, dump, 2½-ton, 6×6	2½	4	5	5	3	20 ^c	67.5 sq ft

Nomenclature	Off-road (tons)	Highway average (tons)	Highway maximum (tons)	Towing capacity (tons)		Passengers ^a	Cargo space
				Highway	Cross-country		
Trk, shop, van, 2½-ton, 6×6, M220	2½	3½	3½	4	3	-----	-----
Trk, shop, van, 2½-ton, 6×6, M292	2½	2½	2½	4	3	-----	-----
Trk, tk, gas, 2½-ton, 6×6, M217	750 gal.	1,200 gal.	1,200 gal.	-----	-----	-----	-----
Trk, tk, water, 2½-ton, 6×6 M222	1,000 gal.	1,000 gal.	1,000 gal.	-----	-----	-----	-----
Trk, cgo, 5-ton, 6×6 (single tires)	5	6	7½	15	7½	20 ^f	550 cu ft
Trk, cgo, 5-ton, 6×6 (dual tires)	5	6	10	15	7½	20 ^f	550 cu ft
Trk, dump, 5-ton, 6×6 --	5	7½	7½	15	7½	15 ^c	135 cu ft
Trk, cgo, prime mover, 10-ton, 6×6, M125	10	10	15	25	15	-----	496 cu ft

^a Based on 18 inches per man. Does not include driver or assistant.
^b Less individual field equipment.

^c Recommended for emergency use only. No troop seats provided.

^d Not generally used for this type of operation.

^e For short hauls; reduce to 16 for long hauls.

^f For short hauls; reduce to 18 for long hauls.

c. Specific Loads. A transport mission may require the movement of a number of specific loads consisting of one or more items which may or may not be packaged (aircraft engines, missile components) and which because of their peculiarities in either size, shape, cube, or weight, involve a variation of the normal planning process to determine vehicle requirements for the operations. In such a case, vehicle requirements may be determined through test loading or by using operational data available from previous similar operations. If test loading is not feasible or operational data is unavailable, vehicle requirements may be determined using the following method:

(1) First, determine the number of items that can be transported by one vehicle. This can be computed by using either cargo weight ((a) below) or cargo cube ((b) below), or if the circumstances warrant, by using both methods to arrive at an optimum figure.

(a)
$$\frac{\text{Vehicle payload capacity}}{\text{weight of item}}$$

=number of items, by weight, that may be loaded onto one vehicle

(b)
$$\frac{\text{Vehicle cargo compartment cube}}{\text{cube of item}}$$

=number of items, by cube, that may be loaded onto one vehicle

(2) Secondly, using the appropriate single vehicle load (the lesser of (a) and (b) above)

when vehicle capacity is figured both ways, compute the number of vehicles required as follows:

$$\frac{\text{Number of items to be transported}^*}{\text{Number of items that can be loaded onto one vehicle}} = \text{vehicles required}$$

Note. When the vehicle load capacity is computed both ways, use the lesser of the results obtained by using methods described as (a) and (b) under (1) above because: If (a) is the lesser, it indicates that the weight of the computed load will exceed the vehicle payload capacity before all available cargo space is filled. If (b) is the lesser, it indicates that the computed cargo load will "cube out" (exceed the cubic cargo space available in the vehicle) before it exceeds the vehicle payload capacity.

d. Vehicle Payload Capacity. The vehicle payload (off-road or on-highway as applicable) and the cubic capacity of the vehicle cargo compartment may be obtained from the vehicle data plate, vehicle technical manual, or tables 3-7 through 3-11 in this chapter. The weight and/or cubic volume of the specific item or load to be transported can be obtained from the shipper, the service representative, or the technical manual applicable to the particular item of equipment to be transported.

*This figure may be a one-time lift or a day-to-day lift, depending upon the mission.

3-41. Highway Tonnage Capabilities

a. In selecting the routes over which cargo is to be hauled, considerations must be given to the capabilities of the roads and bridges to sustain the operation. The gross weight of the heaviest loaded vehicle should not exceed the rated tonnage capacity of the weakest bridge unless it is determined that such bridges will be strengthened. It is difficult to determine the exact tonnage capabilities of highways for sustained operations because of the number of varying conditions which may prevail. Also, the volume of tactical, administrative, and local traffic traveling over the supply routes may exceed the number of cargo-

hauling vehicles which further restricts the capabilities of highway transport.

b. Table 3-12 may be used as a guide in the absence of more accurate data for estimating the supply support tonnage capabilities of highways under varied conditions, assuming that operations are sustained, adequate road maintenance is provided, and the road bears two-way traffic. In using the table of reductions, when more than one limiting factor is involved, apply the narrow roadway factor first; then to the new capability, apply one of the next three on terrain; finally to the latter adjustment, apply the weather factor if the conditions are for a sustained period.

Table 3-12. Highway Tonnage Capabilities

Highway type	Daily tonnage forward (short tons)			Reductions applicable to various conditions (percentage)				
	Optimum dispatch route only	Supply traffic communica- tions zone	Supply traffic combat zone	Narrow roadway (less than 24 ft or 7.20 meters)	Rolling terrain	Hills with curves	Mountain- ous	Seasonal bad weather
Concrete -----	60,000	36,000	8,400	25	10	30	60	20
Bituminous -----	45,000	27,000	7,300	25	10	30	60	30
Bituminous treated --	30,000	18,000	5,800	25	20	40	65	40
Gravel -----	10,150	6,090	3,400	25	20	50	70	60
Dirt -----	4,900	2,940	1,600	25	25	60	80	90

3-42. Formulas for Determining Unit and Vehicle Requirements

The following formulas are applied in computing unit or vehicle requirements on the basis of planning data discussed in paragraphs 3-39 and 3-40, actual operational data, or a combination of both. The number of units or vehicles required for workloads expressed in gallons, persons, or other units of measure can be determined by substituting that unit of measure for tons in the formulas.

a. *One-Time Lifts.* To determine the number of truck companies or vehicles required to move a given number of tons in one lift, substitute appropriate figures in the following formula:

$$\text{Companies required} = \frac{\text{tons to be lifted}}{\text{tons per vehicle} \times \text{vehicles available per company}}$$

$$\text{Vehicles required} = \frac{\text{tons to be lifted}}{\text{tons per vehicle}}$$

b. *Turnaround Time.* To determine turn-

around time, use the following formula. (Caution must be exercised to make sure that the delay factor is accurate. Turnaround time should be rounded off to the nearest tenth for use in computations.)

$$\text{Turnaround time} = \frac{2 \times \text{distance}}{\text{rate of march (mih)}} + \text{delays}$$

c. *Distance Between Truck Terminals or Trailer Transfer Points.* When locating truck terminals or trailer transfer points, the following formula is used to determine the appropriate distance between these installations in order to obtain a specific turnaround time:

$$\text{Distance} = \frac{\text{hours per operating shift} - \text{delays} \times \text{rate (mih)}}{2}$$

d. *Sustained Operations.* The following formula is used to determine the number of truck companies required to move a given daily tonnage in sustained operations. (This formula is applicable to both local and line-haul operations.

The number of vehicles required can be determined by omitting vehicles available per company from formula):

$$\text{Companies required} = \frac{\text{daily tonnage} \times \text{turnaround time}}{\text{tons per vehicle} \times \text{vehicles available per company} \times \text{operational day}}$$

3-43. Line-Haul Operational Planning Exercise

The following procedure demonstrates the method of planning and setting up a motor transport line-haul move involving trailer transfer operations. For the purpose of planning this exercise, the location of support facilities involved, the routes to be used, and the distances between points over which the operations will be conducted are shown in figure 3-17.

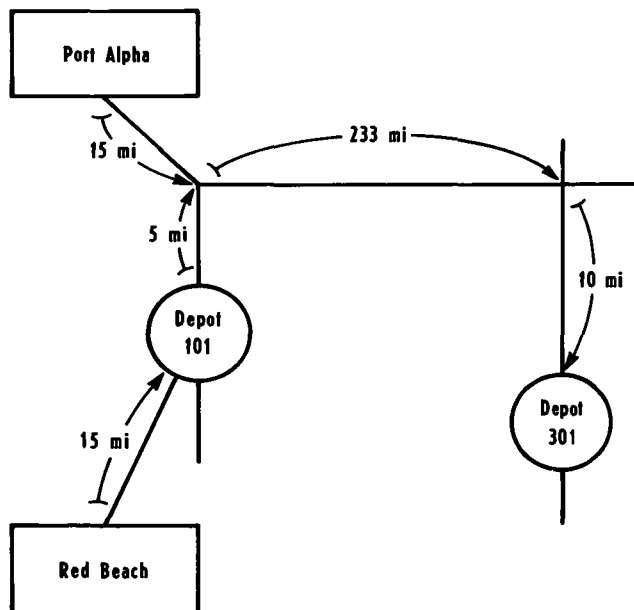


Figure 3-17. Route and facilities diagram.

a. Tonnages to be moved by Motor Transport.

(1) Information provided by the staff movements officer establishes tonnages to be moved by highway as follows:

3,600 short tons from Port Alpha to Depot 301

2,400 short tons daily from Red Beach to Depot 101

1,500 short tons daily from 101 to Depot 301.

(2) A graphic portrayal of the daily tonnages to be moved between activities and the routes over which these tonnages will move in this operation are illustrated in figure 3-18. The daily movement of 3,600 short tons from Port Alpha forward and of the 1,500 short tons from Depot 101 have been combined at the point on the route where these forward movements coincide. This provides a realistic picture of the flow of tonnages over the road and a working aid in planning for an operation of this type.

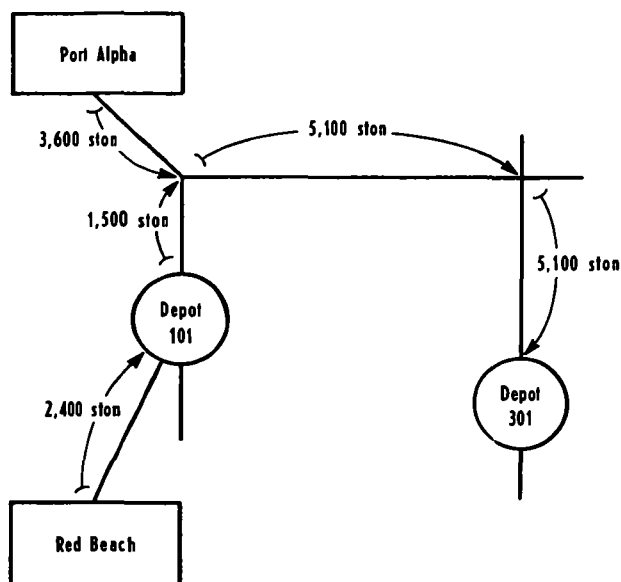


Figure 3-18. Tonnage information diagram.

b. *Operational Planning Factors.* The following operational factors will govern the planning for this operation:

- (1) Round-the-clock operation—two 10-hour shifts.
- (2) Vehicles available per unit—42.
- (3) Load per 2½-ton truck—3.5 tons.
- (4) Load per 12-ton cargo semitrailer—10 tons.

Note. Cargo to be transported is of a type that permits vehicles to be loaded to rated weight capacities without exceeding cube capacities of cargo compartments.

(5) Rate of march: 20 mih—main supply route between origin and destination terminals.

15 mih—Port Alpha to origin terminal, Depot 101 to origin terminal, destination terminal to Depot 301.

10 mih—Red Beach to Depot 101.

(6) Delay times:

2.5 hours per round trip for loading and unloading straight (1.25 hours for loading and 1.25 hours for unloading).

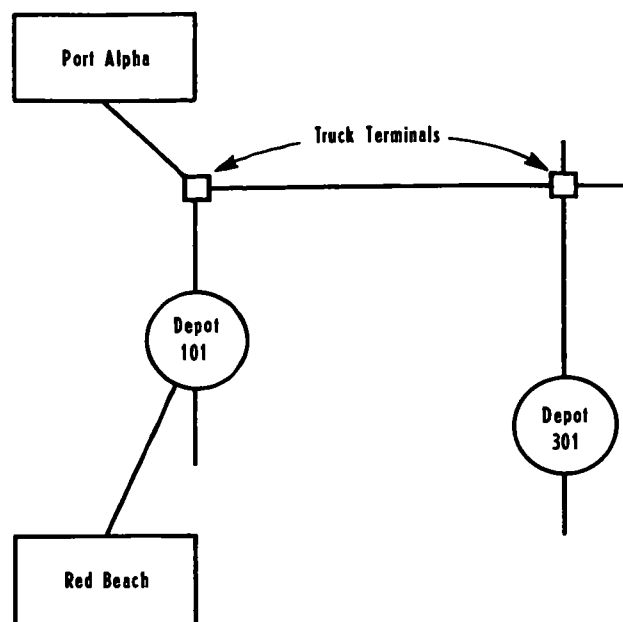
1 hour per relay (round trip per leg) for truck tractors engaged in line haul operations and/or shuttle operations between terminals and supported agencies.

c. *Location of Truck Terminals.* Because the operation involves a line haul and the distances and operating factors dictate the establishment of short haul and/or shuttle tractor operations in conjunction with a trailer relay operation, it is necessary to determine the approximate locations of the origin and destination truck terminals for the line haul task in order to separate the line haul from local operations and to identify specific workloads and tasks.

(1) The origin truck terminal should be centrally located near the road intersection between Port Alpha and Depot 101, provided a suitable site is available.

(2) The destination truck terminal should be located near the intersection north of Depot 301 to be near the cargo's destination and to be on the main route to allow for expansion forward without relocation (fig. 3-19).

d. *Location of Trailer Transfer Points.* Before determining and computing the type and number of truck units required for each task for the line haul, the location of trailer transfer points to divide the line haul into legs must be determined so that total delays and total turnaround time for the entire line haul can be computed. The distance to allow between trailer



Figures 3-19. Location of truck terminals.

transfer points to obtain a turnaround time of 10 hours (one shift in the operational day) is obtained as follows: (the 1-hour delay in the formula is to 1-hour relay time per line haul leg).

$$\begin{aligned} \text{Distance} &= \frac{10 \text{ hours per operating shift} - 1 \text{ hour delay} \times 20 \text{ mih}}{2} \\ &= \frac{(10-1) \times 20}{2} = 90 \text{ miles between trailer transfer points} \end{aligned}$$

Trailer transfer points are then located as shown in figure 3-20. In addition of the consideration of distance to allow for the most desirable turnaround time, the planner must consider suitable sites for locating these facilities. Note that the short leg (53 miles) has been placed forward. This is to avoid relocating any but the most forward trailer transfer point if the operation is expanded.

e. *Types of Units Required.* Based on the preceding information, specific tasks, workloads, and the types of units required to perform the various transport missions of this operation can now be determined. A study of the overall operation including the types of hauls involved, the operating areas, and the daily tonnage requirements indicates that the

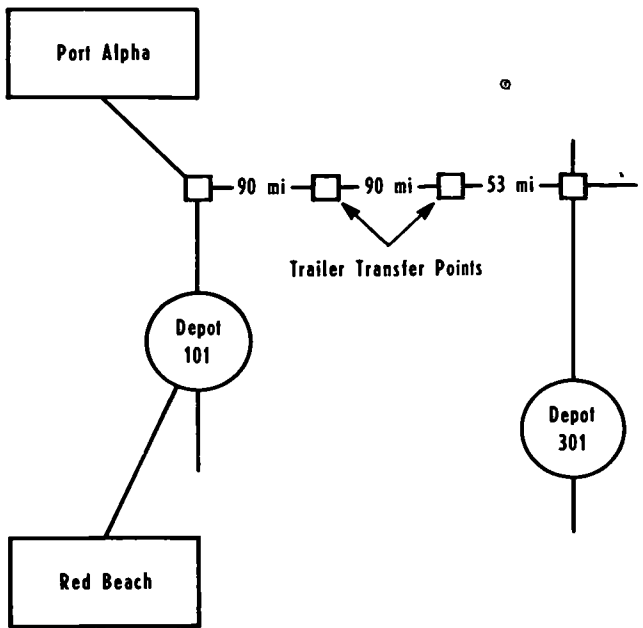


Figure 3-20. Location of trailer transfer points.

following types of units would be most suitable, for the missions as indicated:

(1) Line haul from the truck terminal to Depot 301: 5,100 short tons, medium truck companies.

(2) Port Clearance from Port Alpha to origin truck terminal: 3,600 short tons, medium truck companies.

(3) Beach Clearance from Red Beach to Depot 101: 2,400 short tons, light truck companies (2½-ton).

(4) Delivery of cargo from Depot 101 to origin truck terminal: 1,500 short tons, medium truck companies.

(5) Delivery of cargo from destination truck terminal to Depot 301: 5,100 short tons, medium truck companies.

f. Computing for Medium Truck Companies Required for Line-Haul Tasks.

Daily tonnage: 5,100

Turnaround time

$$= \frac{2 \times 233}{20 \text{ mi}} + 3 \text{ hours delay (1 hour for each relay),} \\ 1 \text{ operating (10-hour) shifts} = 26.3 \text{ hours}$$

Tons per vehicle (12-ton semitrailer): 10 short tons

Vehicles available per company: 42

Operational day: 20 hours

Thus

Companies required

$$= \frac{5,100 \text{ short tons} \times 26.3 \text{ hours}}{10 \text{ short tons} \times 42 \text{ vehicles} \times 20 \text{ hours}} \\ = 15.93 \text{ or } 15.9 \text{ medium truck companies required}$$

g. Computing for Medium Truck Companies Required for Local Hauls.

(1) Movement of 5,100 short tons from destination truck terminal to direct support activity (Depot 301):

Daily tonnage: 5,100 short tons

$$\text{Turnaround time} = \frac{2 \times 10 \text{ miles}}{15} + 1 \text{ hour delay (1 hour relay time)} \\ = 2.33 \text{ hours}$$

Tons per vehicle (12-ton semitrailer): 10 short tons

Vehicles available per company: 42

Operational day: 20 hours

Thus

$$\text{Companies required} = \frac{5,100 \text{ short tons} \times 2.33}{10 \text{ short tons} \times 42 \times 20} \\ = 1.41 \text{ or } 1.5 \text{ medium truck companies required}$$

(2) Movement of 3,600 short tons from Port Alpha to the origin truck terminal:

Daily tonnage: 3,600 short tons

$$\text{Turnaround time} = \frac{2 \times 15 \text{ miles}}{15 \text{ mi/h}} + 1 \text{ hour delay (1 hour relay time)} \\ = 3 \text{ hours}$$

Tons per vehicle (12-ton semitrailer): 10 short tons

Vehicles available per company: 42

Operational day: 20 hours

Thus

$$\text{Companies required} = \frac{3,600 \text{ short tons} \times 3 \text{ hours}}{10 \text{ short tons} \times 42 \text{ vehicles} \times 20 \text{ hours}} \\ = 1.28 \text{ or } 1.3 \text{ medium truck companies required}$$

(3) Movement of 1,500 short tons from Depot 101 to the origin truck terminal:

Daily tonnage: 1,500 short tons

$$\text{Turnaround time} = \frac{2 \times 5 \text{ miles}}{15 \text{ mi/h}} + 1 \text{ hour delay (1 hour relay time)} \\ = 1.66 \text{ hours}$$

Tons per vehicle (12-ton semitrailer): 10 short tons

Vehicles available per company: 42

Operational day: 20 hours

Thus

$$\begin{aligned}\text{Companies required} &= \frac{1,500 \text{ short tons} \times 1.66 \text{ hours}}{10 \text{ short tons} \times 42 \times 20 \text{ hours}} \\ &= .29 \text{ or } .3 \text{ medium truck companies} \\ &\quad \text{required}\end{aligned}$$

h. Total Medium Truck Companies Required.

(1) The total medium truck companies required for local and line-haul tasks are as follows:

15.9 line haul
1.5 destination truck terminal to Depot 301
1.3 Port Alpha to origin truck terminal
3 Depot 101 to origin truck terminal

19.0 truck companies

(2) Thus 21 medium truck companies are required to accomplish all tasks for which medium companies have been selected. In this operation the workload is shared among all medium truck companies since all are connected with the semitrailer relay operation. Therefore, the fractional part of the unit requirement for each task is retained and included in the total, and the total is then rounded off to the next higher number of units. However, where the workload cannot be shared among units doing varied tasks, the unit requirement for each task must be rounded off to the next higher whole number. (Each of the medium truck companies requires two semitrailers per tractor since all units will be involved in semitrailer relay operations.)

i. Computing for Light Truck Companies Required for Beach Clearance. Computation of the number of light truck companies required for moving 2,400 short tons daily from Red Beach to Depot 101 is as follows:

Daily tonnage: 2,400 short tons

$$\begin{aligned}\text{Turnaround time} &= \frac{2 \times 15 \text{ miles}}{10 \text{ mi/h}} + 2.5 \text{ hours delay} \\ &\quad (2.5 \text{ hours per round trip for loading and unloading} \\ &\quad \text{straight trucks}) = 5.5 \text{ hours}\end{aligned}$$

Tons per vehicle (2½-ton truck): 3.5 short tons

Vehicles available per day: 42

Operational day: 20 hours

Thus

$$\begin{aligned}\text{Companies required} &= \frac{2,400 \text{ short tons} \times 5.5 \text{ hours}}{3.5 \text{ short tons} \times 42 \times 20 \text{ hours}} \\ &= 4.48 \text{ or } 5 \text{ light truck companies} \\ &\quad \text{(fraction raised to next higher} \\ &\quad \text{number)}\end{aligned}$$

Note. Three teams, GD, light truck squad (TOE 55-540) may be used as augmentation to meet the transport capability required by the .48 percent required over four companies. This would eliminate the need to assign a full five companies to the operation.

j. Control Units Required. Based on the preceding computations, 19 medium truck companies and either four light truck companies with augmentation or five full light truck companies are required for the operation. In addition, four teams (team GF, TOE 55-540) are required to move the two trailer transfer points and the transfer operations in the truck terminals. For command and control of these units, four motor transport battalions and one motor transport group are required. (See FM 101-10-2, for basis of allocation.) The group commander has overall responsibility for the operation and assigns a specific geographic area to each battalion. The responsibility for operating each truck terminal is assigned to a specific battalion.

Section V. MISCELLANEOUS

3-44. Maintenance Organization

Category	Definitions	Scope	Performed by	Responsibility of
Organizational	That maintenance normally authorized for, performed by, and the responsibility of a using unit on equipment in its possession. This maintenance consists of functions and repairs within the capabilities of authorized personnel skills, tools, and test equipment as prescribed in unit's TOE or TD. (Formerly known as 1st and 2d echelon maintenance.)	Care taken of, and maintenance performed on equipment to keep it in a serviceable condition in accordance with applicable DA publications, such as TM's, TB's, LO's, and equipment serviceability criteria. These functions consist of: inspections, servicing, adjustments, lubrication, scheduled services, minor repairs, proper operation, records, and equipment serviceability criteria. All repair parts, replacements, and levels must be in accordance with prescribed load list and levels as prescribed by TOE and TD.	Operator of crew and organizational mechanics.	Unit commander.
Direct support	Maintenance normally authorized for, performed by, and the responsibility of designated maintenance activities. Direct support maintenance units provide support where feasible by on-site repair, replacement of assemblies and components, delivery of parts to the user, and technical assistance. Normally, TOE and TD of direct support organizations specify this unit as having a maintenance mission and provide using units with on-site repairs. (Formerly known as 3d echelon maintenance.)	Provide for replacement of major parts, components, assemblies, and end items. Arrange for the evacuation of unserviceable equipment from user to an activity where repairs can be accomplished or to a collection or salvage facility. Assist in the performance of maintenance inspections of equipment and of organizational maintenance operations of the user to ascertain the condition of equipment and the effectiveness of organizational maintenance. Provide repair parts support, technical advice to units supported, maintenance float items, and inspection personnel.	Units having DSU responsibility (maintenance mission)	Army commander, division commander, installation commander.

General support

Maintenance normally performed by semimobile units in support of the supply system or when required, to support direct support units in the maintenance and repair for return to user.

Provide for the repair of end items and assemblies for return to the supply system or maintenance float. The performance of maintenance is accomplished through use of maintenance standards. This includes the overhaul and repair of end items and components for return to stock. Provide inspection personnel.

Units having GSU responsibility.

Army field commanders.

Depot

Maintenance normally performed by permanent installations using extensive equipment.

Provide for overhaul and repair of economically repairable materiel, augment the procurement program in satisfying overall Army requirements and when required, provide for repair of materiel beyond the capability of general support maintenance organizations and the maintenance of depot stock in a ready-for-issue condition.

Depot maintenance units.

Chief of Army Materiel Command.

3-45. Bivouac Defense

a. General. The security of a truck company's bivouac area is primarily the responsibility of the company commander. Since the success of any defense plan depends upon the training of the men and their ability to react rapidly when attacked, intensive training in defense is also a unit commander's responsibility. Both active and passive defense are employed to protect a truck company bivouac area. Active defense is generally employed against ground attack. A unit employs limited offensive action and counterattacks to deny the bivouac site to a hostile force. Passive defense is used primarily against air attack; a truck company uses such protection as that offered by concealment, dispersion, and deception to protect itself without taking the offensive.

b. Active Defense. Active defense of a truck company's site does not include aggressiveness beyond the perimeter of the bivouac area. Except for those who man machineguns and observations and listening posts, members of the unit do not penetrate beyond the bivouac boundaries. Because ground forces may strike a truck company at several points simultaneously or in concert with airborne forces before mobile defense forces can reach the company commander, the company commander must be prepared to employ his own forces effectively at all times. Consequently, it is assumed in this text that the defense of the unit will be handled by the truck unit without outside assistance. A typical bivouac is illustrated in figure 3-21.

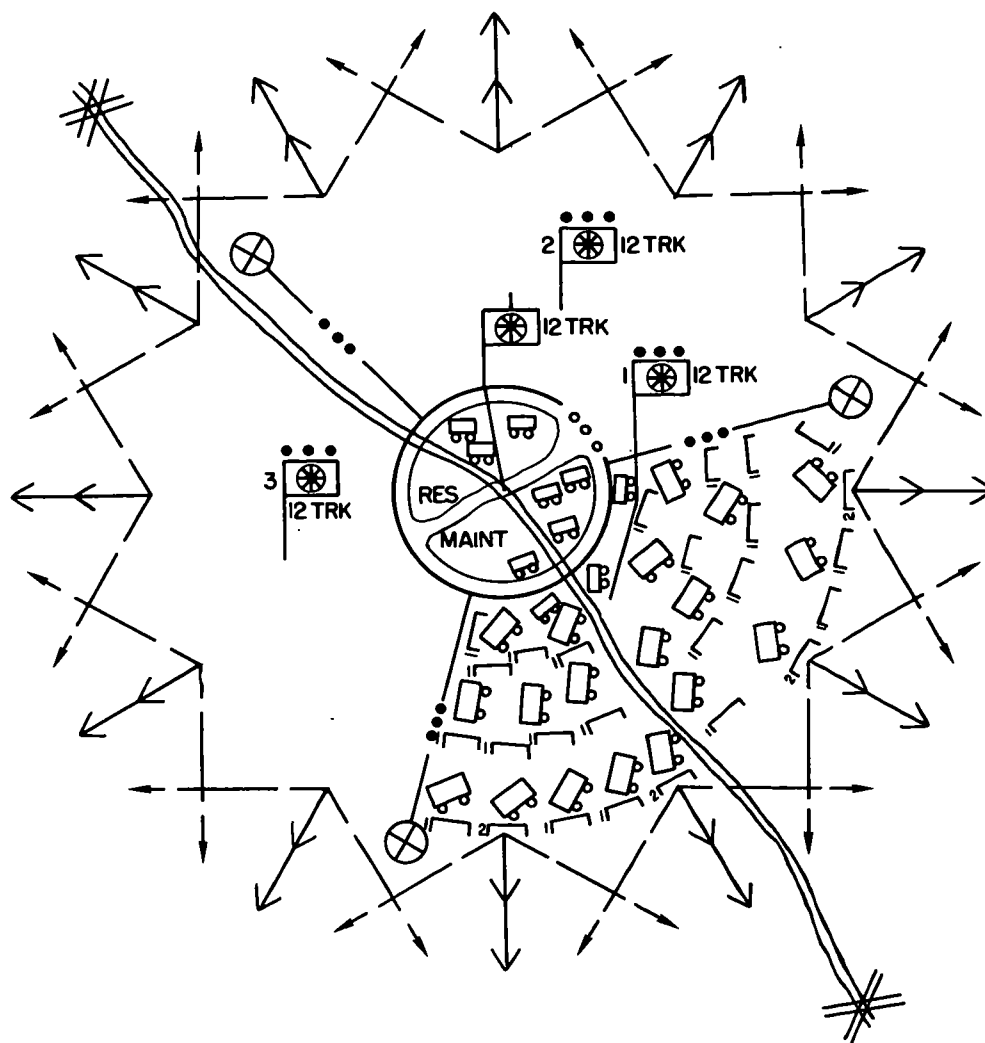
(1) *Two-stage alert.* The alarm system for a truck company usually provides for a two-stage alert. The first stage, attack-likely, warns unit personnel by audible or unusual signals that an attack will probably take place, troops are positioned in pairs with one man remaining alert at all times. If the situation permits, the other member of the team may sleep. During the attack-likely alert, those who are not actively performing duties which are a part of the unit's primary function man their defensive positions. At this time, every effort should be made to continue with the unit's normal mission. When the second stage alarm is given, attack-imminent, all personnel discontinue their routine duties and man their defensive posi-

tions. The reserve force is not committed at this time, but is held in position, usually near the command post, until deployed by the company commander. Personnel remain in their defensive positions until the all-clear signal is given.

(2) *Firing on the enemy.* When enemy forces are observed advancing on the bivouac, they are fired on by the longest range weapons available. This fire must cover the withdrawal of outposts when the enemy threatens their security. Attacks must be kept under accurate fire as they approach; when they are within assaulting distance, approximately 150 yards or less, they should be hit with maximum volume from all weapons available. Defensive troops should not engage in close combat before attacking forces reach the prepared defensive positions. Enemy combat elements sighted in the vicinity should not be fired upon when it is apparent that they intend to bypass the truck company bivouac. However, information of enemy troops in the area should be expeditiously forwarded to the nearest senior commander of friendly forces.

(3) *Counterattacking.* Every effort to destroy the enemy must be made if he penetrates the perimeter defense and threatens the unity of internal defense. Failing this, the commander may use his reserve forces to destroy attackers and restore the integrity of the company's position and block farther advance by the enemy. Without supporting artillery and air defense and lacking the shock of armor, the advantage of counterattacking must be weighed against the advantages of continuing the fight from positions which offer some cover from enemy fire. A counterattack is launched only when there is a reasonable chance of destroying the enemy forces or driving them outside the perimeter defense. Defense of the area does not include pursuit of hostile forces.

(4) *Withdrawing.* When confronted with a superior force which threatens large-scale defeat or destruction, support units are normally not bound to defend their areas at all costs; they may withdraw with approval of the next higher command. However, unit defense plans include provisions for adequate striking forces for counterattacks to make with-



COMPANY AREA: .0959 SQ MILES OR 61.4 ACRES
COMPANY FRONT: 1,900 YD (1,737 METERS)
PLATOON FRONT: 630 YD (576 METERS)
CP AREA: 75-YD (69 METERS) RADIUS

Figure 3-21. Truck bivouac area organized for defense against ground attack.

drawal unnecessary. When withdrawal is necessary, the commander must make the decision and execute it before the defending force is heavily engaged with the attacking force. When contact with the enemy has been established, a small detachment is detailed to cover the withdrawal. Before withdrawing from the area, all equipment, supplies, and ammunition that may be of value to the enemy must be destroyed. When possible, the retreating detachment is provided with motor transportation.

During periods of active engagement with the enemy, the company commander should be continuously advised with situation and status reports from elements engaged. All means of communication should be used in keeping the company commander informed so that he may make logical decisions to cope effectively with the situation.

(5) *Passive defense.* Concealment and dispersion are important passive defense measures against attack, especially from the air.

The unit commander directs the construction of two-man foxholes with adequate overhead concealment immediately after occupying a site. Foxholes are usually camouflaged with growth from the surrounding area. The use of wooded areas, smoke, blackout lights, cover for reflective surfaces, protective shadows, and limiting movements are means of concealment. Dispersion reduces the amount of personnel and equipment which can be damaged by a single projectile. The enemy can be deceived about the location of a bivouac by making vehicle tracks into an unoccupied wooded area and concealing tracks leading to the true location of the bivouac.

3-46. Typical Truck Terminal

Figure 3-22 shows a typical origin truck terminal. Arrangement of facilities may deviate from the illustration, but the facilities indicated should be considered the minimum necessary for effective operation of the terminal.

3-47. International (Geneva Convention) Road Signs

The road signs discussed in this paragraph were agreed upon at the United Nations Conference on Road and Motor Transport in 1949. Although these signs are not military, Army personnel should be familiar with them since they are used in overseas areas.

a. Dimensions of Signs. Dimensions of various signs are standardized in each country to insure maximum uniformity. In general, two sizes are used for each type of sign—a standard size and a reduced size for use where conditions do not permit or the safety of road users does not require erection of the standard size. In exceptional circumstances, a small sign may be used inside built-up areas or for repetition of the main sign.

b. Danger Signs (Class I) (Fig. 3-23). Danger signs are in the shape of an equilateral triangle with one point upward, except in the case of the sign PRIORITY ROAD AHEAD which has one point downward. These signs have red borders with white or yellow backgrounds. Symbols are black or some other dark color. For signs of standard size, the length of each side of the triangle is not less than two

feet 11.4 inches (0.90m), and, for the reduced size, not less than 1 foot 11.6 inches (0.60 m). Signs are not more than 7 feet 2.6 inches (2.20 m) above the ground at the highest point. Away from built-up areas, they are not less than 1 foot 11.6 inches (0.60 m) above the ground at the lowest point. Signs are so placed that they are clearly visible but do not impede pedestrians.

c. Signs Giving Definite Instructions (Class II). The signs of this class indicate an order, which may be in the nature of either a prohibition or an obligation (fig. 3-24). They are circular with a diameter of at least 1 foot 11.6 inches (0.60 m) for signs of standard size, and at least 1 foot 3.7 inches (0.40 m) for signs of reduced size. They are placed in the immediate vicinity of the point where the prohibition or obligation begins and at intervals along the route. They are not more than 7 feet 2.6 inches (2.20 m) above the ground at the highest point, and not less than 1 foot 11.6 inches (0.60 m) above the ground at the lowest point.

(1) *Prohibitory signs (class II A).* These signs are white or light yellow with red borders, and the symbols are black or some other dark color. Examples of signs in this category are—

(a) Prohibitions for all traffic.

(b) Prohibitions for certain classes of vehicles.

(c) Restrictions on the dimensions, weight, or speed of vehicles.

(2) *Mandatory signs (class II B).* These signs are blue with white symbols. Examples of mandatory signs are—

(a) A direction to be followed.

(b) Where cyclists must ride.

d. Informative Signs (Class III) (Fig. 3-25). Signs of this class are rectangular. Where the colors are not specifically prescribed, red does not dominate.

(1) *Indication signs (class III A).* Signs of this type are used to indicate parking areas, hospitals, first aid stations, telephones, filling stations, and priority roads. These signs have blue backgrounds, except those indicating priority roads. Signs indicating priority roads are diamond-shaped and are white with black or dark rims on the outside and have yellow cen-

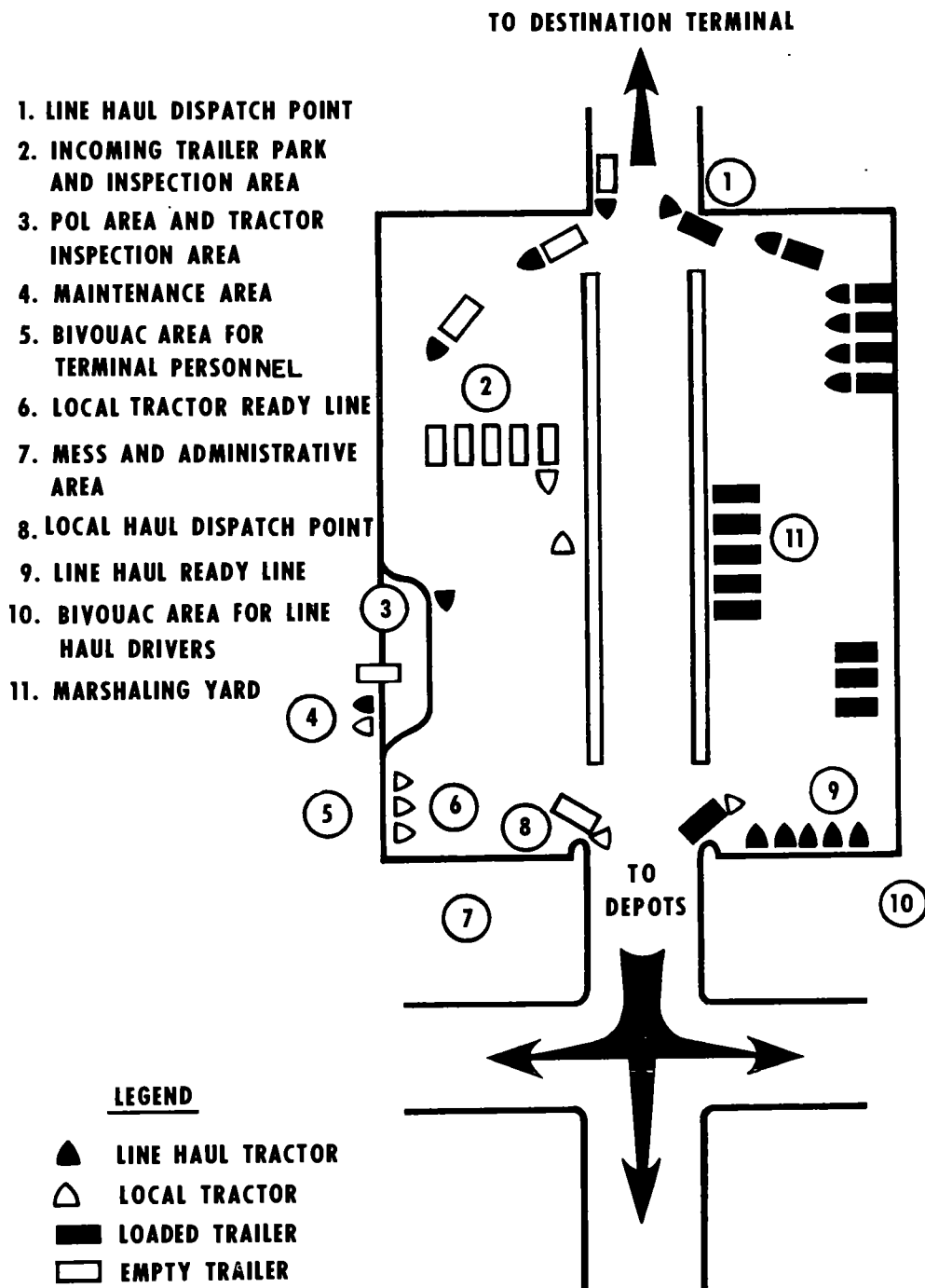
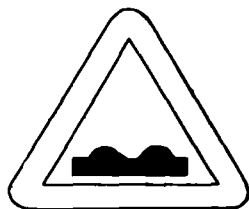
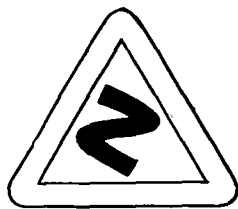


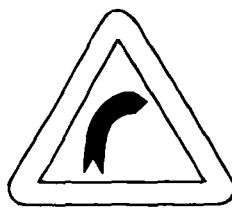
Figure 3-22. Origin truck terminal.



UNEVEN ROAD



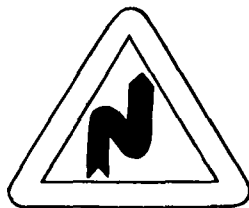
DANGEROUS BEND



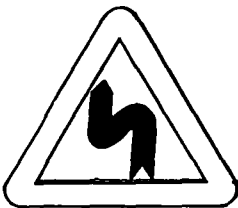
RIGHT BEND



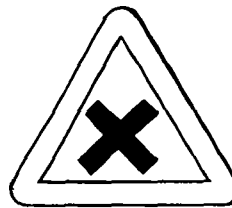
LEFT BEND



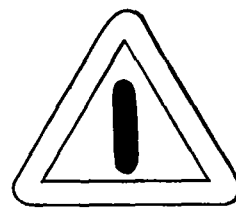
DOUBLE BEND
(FIRST TO THE RIGHT)



DOUBLE BEND
(FIRST TO THE LEFT)



ROAD INTERSECTION



OTHER DANGER



OPENING BRIDGE



ROAD REPAIR



SLIPPERY ROAD



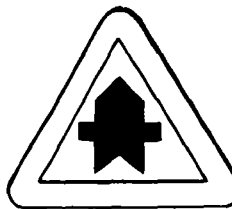
PEDESTRIAN
CROSSING



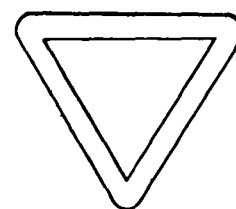
CHILDREN



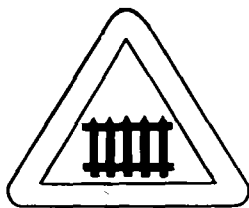
BEWARE OF
ANIMALS



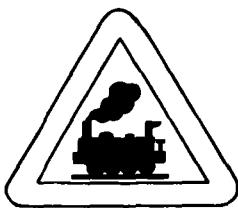
INTERSECTION
WITH NONPRIORITY
ROAD



PRIORITY ROAD
AHEAD



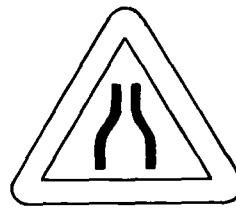
LEVEL R.R. CROSSING
WITH GATES



LEVEL CROSSING
WITHOUT GATES
(APPROACH SIGN)



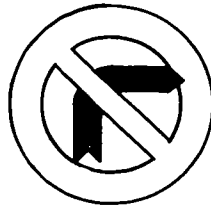
DANGEROUS HILL



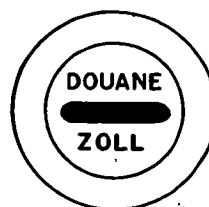
ROADWAY NARROWS



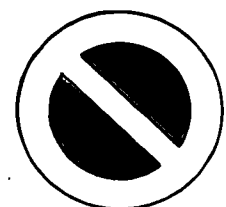
STOP AT
INTERSECTION



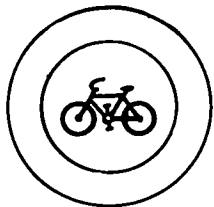
NO RIGHT TURN



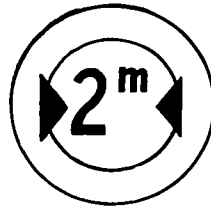
STOP--CUSTOMS



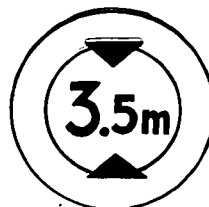
NO STOPPING
OR WAITING



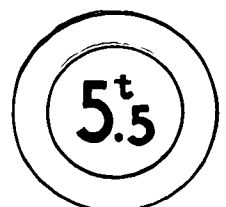
BICYCLES
PROHIBITED



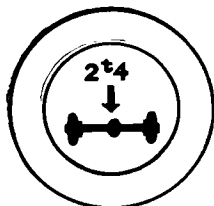
NO ENTRY FOR VEHICLES
HAVING OVERALL WIDTH
EXCEEDING _____ METERS



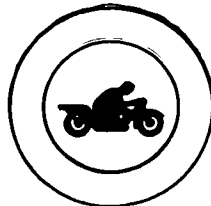
NO ENTRY FOR VEHICLES
HAVING OVERALL HEIGHT
EXCEEDING _____ METERS



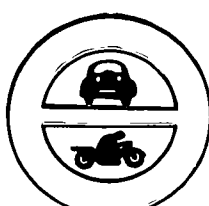
NO ENTRY FOR VEHICLES
EXCEEDING _____ GROSS
WEIGHT



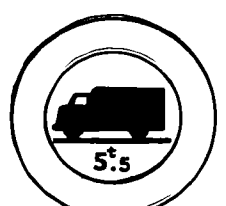
NO ENTRY FOR VEHICLES
WITH AN AXLE WEIGHT
EXCEEDING _____ TONS



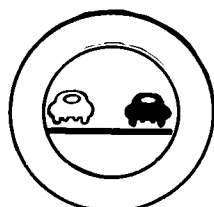
NO ENTRY FOR
MOTORCYCLES
W/O SIDECARS



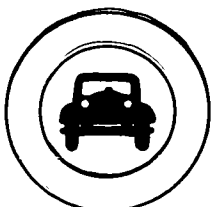
NO ENTRY FOR
ALL MOTOR
VEHICLES



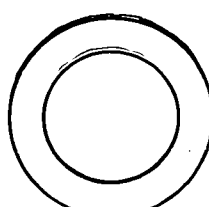
NO ENTRY FOR GOODS-
CARRYING VEHICLES
EXCEEDING _____ TONS
LADEN WEIGHT



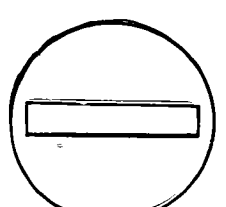
NO PASSING



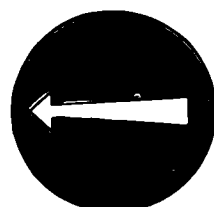
NO ENTRY FOR ALL
VEHICLES EXCEPT
MOTORCYCLES W/O
SIDECARS



CLOSED TO ALL
VEHICLES



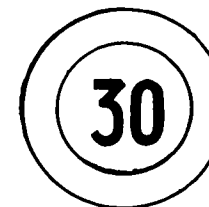
NO ENTRY FOR
ALL VEHICLES



TURN LEFT



COMPULSORY CYCLE
TRACK

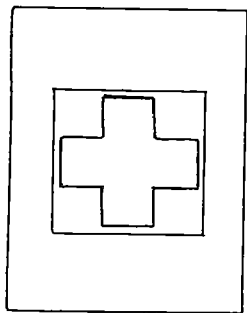


SPEED LIMIT

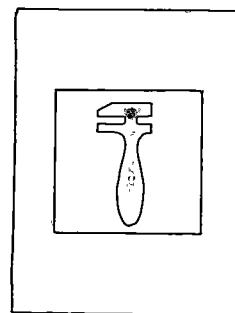
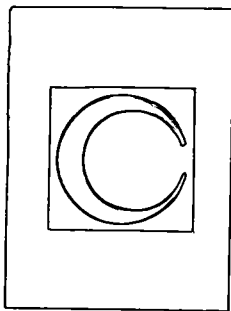


NO PARKING

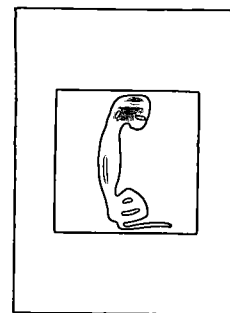
Figure 3-24. International road signs—definite instructions.



FIRST-AID STATION



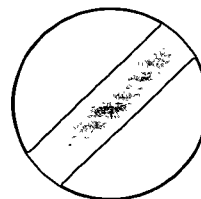
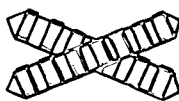
MECHANICAL HELP



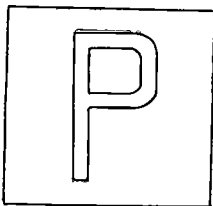
TELEPHONE



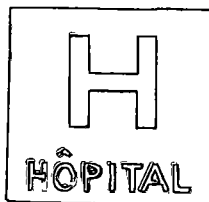
LEVEL R.R. CROSSING WITHOUT
GATES IN IMMEDIATE VICINITY



END OF SPEED LIMIT



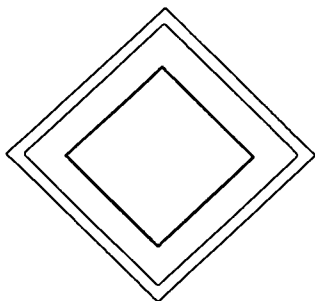
PARKING
PERMITTED



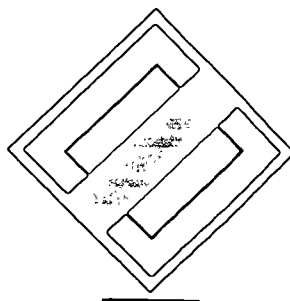
HOSPITAL



FILLING STATION

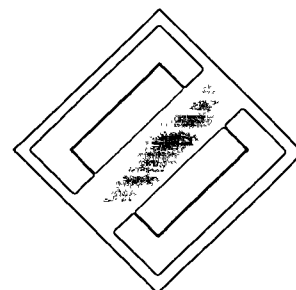


PRIORITY ROAD



200m

APPROACH TO END OF
PRIORITY ROAD



END OF PRIORITY ROAD

ters. Priority road signs are square with one point downward. The side of the square is at least 1 foot 11.6 inches (0.60 m) for the standard size and at least 1 foot 3.7 inches (0.40 m) for the reduced size. For signs repeated within builtup areas, the side of the square is 9.8 inches (0.25 m).

(2) *Advance direction signs and direction signs (class III B)*. The size of these signs is such that the indication can be understood easily by drivers in time to enable them to comply. They have either light backgrounds with dark lettering or dark backgrounds with light lettering. Advance direction signs are placed at a distance of between 328 feet (100 m and 820 feet (250 m) from the intersection on normal roads. On special roads, e.g., concrete multilane roads, this distance is increased to 1,640 feet (500 m). Direction signs are rectangular with the longer side horizontal and end in an arrowhead. Names of places lying in the same direction may be added to the sign. Colors of these signs are the same as for advance direction signs. When distances are indicated, the figures giving distances are inscribed between the name of the place and the arrowhead.

(3) *Place identification signs (class IIIC)*. Signs indicating a locality are rectangular with the longer side horizontal. They are of such size and location that they are visible at night. They have either light backgrounds with dark lettering or dark backgrounds with light lettering. They are placed before the beginning of a built-up area and at other points necessary to indicate place locations.

3-48. NATO Military Road Signs

To facilitate the movement of armed forces of the North Atlantic Treaty Organization (NATO) in any territory controlled by operational military command or by a national authority, a standard system of military route signs has been adopted by member governments. This system includes signs which the Geneva Convention already prescribes (para 3-47) and others not included in the Geneva Convention. Standard NATO signs are hazard signs, regulatory signs, and guide signs. Examples are shown in figure 3-26.

a. *Hazard Sign*. This sign indicates a traffic hazard and is used only in areas under military authority. A hazard sign is square and is placed with one corner pointing downward. A purely military sign not included in the international (Geneva Convention) system or host country's system has a yellow background with the legend or symbol in black. If the sign is included in the international system or host country's system, the international or host country's sign is used on the same yellow background instead of the black symbol or legend.

b. *Regulatory Sign*. This sign is used to regulate and control traffic and to define the light line. A regulatory sign is square. It has a black background on which the legend is superimposed in white with the following exceptions: bridge classification signs, stop signs, no entry signs, blackout signs, and signs erected by the military to control civilians under specified conditions. Descriptions of the expected regulatory signs are contained in STANAG NO. 2010 and STANAG NO. 2012, Edition No. 2.

c. *Guide Sign*. A guide sign is used to indicate locations, distances, directions, routes, and similar information.

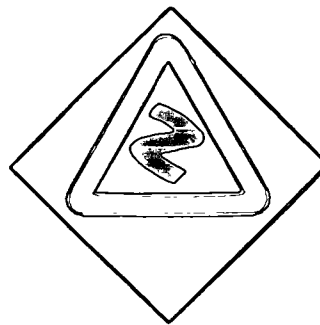
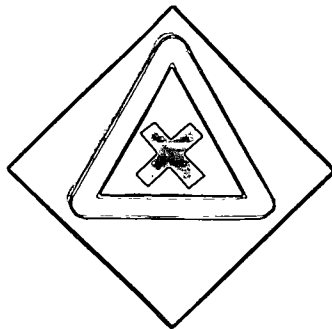
(1) A guide sign for a route is rectangular with the long side vertical. The legend or symbol and route number are superimposed in white on a black background. Odd numbers are used for axial routes, and even numbers designate lateral routes.

(2) A directional disk is used as a supplement to other guide signs to indicate the direction of a route or as an appendage to any major unit sign to indicate the route to that unit. The disk is less than 16 inches (0.41 m) in diameter and has a black arrow, with or without bar, on a white background. Eight equally spaced holes around its circumference allow the disk to be nailed with the arrow pointing in any direction. Battalions and lower units are not permitted to install directional disks.

(3) A guide sign for a casualty evacuation route is either rectangular or cross-shaped with symbols in red on a white background.

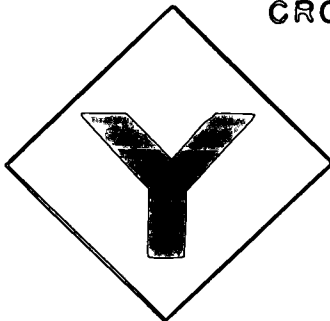
(4) A detour sign has a white arrow, barred or not, on a blue square. The sign is placed so that one corner of the square points downward.

HAZARD

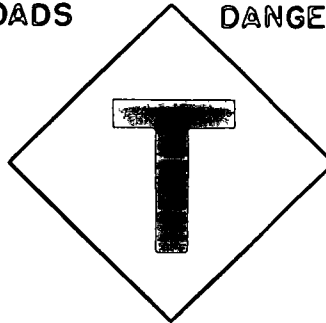


CROSSROADS

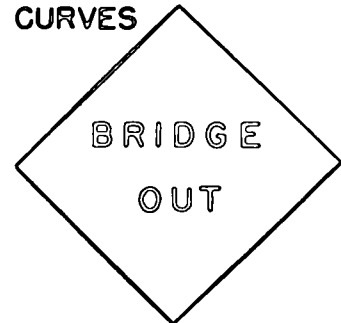
DANGEROUS CURVES



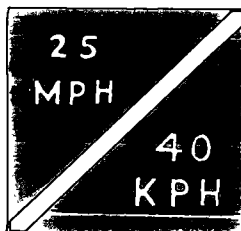
Y-JUNCTION



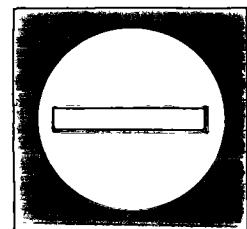
T-JUNCTION



REGULATORY

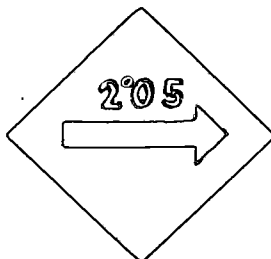


SPEED LIMIT

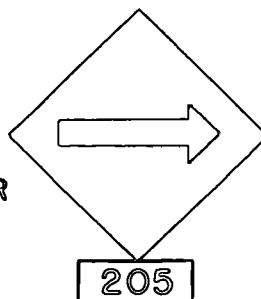


NO ENTRY

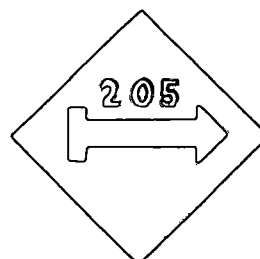
DETOUR



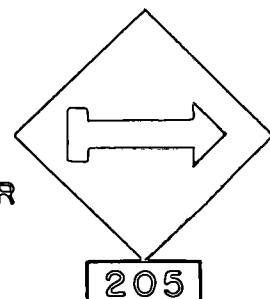
OR



DETOUR TO AXIAL
ROUTE 205 TO FRONT,
TURN RIGHT



OR



DETOUR TO AXIAL
ROUTE 205 TO REAR,
TURN RIGHT

Figure 3-26. NATO military road signs.

3-49. Marking Contaminated or Dangerous Land Areas

Roads and areas within NATO nations containing contamination, minefields, boobytraps, or unexploded bombs will be marked by triangular signs in accordance with the details of the agreement of STANAG NO. 2002. Examples are shown in figure 3-27.

3-50. NATO Markings for Military Vehicles

a. General. The armed forces of NATO have agreed to use the standard markings for vehicles described below. (SEATO Military Vehicle Markings are prescribed by CSTAG 20-27.) The markings listed are not necessarily used at all times, but when they are used, vehicles are marked in accordance with the following paragraphs. The rear of a trailer is marked in the same as its prime mover; there is no need to mark the front of a trailer. When necessary for security reasons, vehicle markings may, by direction of the field com-

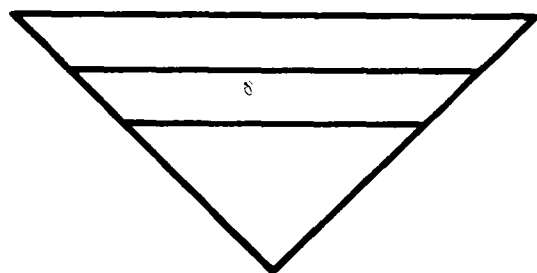
mander or his superior authority, be covered or removed.

b. Registration Numbers. The marking of vehicles for registration is as required by the nation concerned. Registration markings consist of numbers or a combination of letters and numbers.

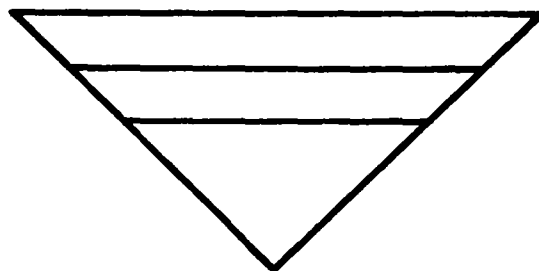
c. National Symbols. National symbols are used to identify the vehicles of each country. At a minimum, symbols are shown front and rear. Service symbols may be superimposed upon the national distinguishing symbols or shown separately by an additional symbol.

d. Speed Limits. Speed limit markings are placed on vehicles as directed by the nation concerned.

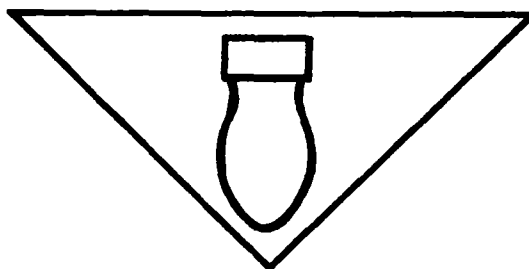
e. Tactical Markings. Tactical markings serve in general as identification markings within units; they consist of stripes and geometrical figures or combinations thereof and may also include a name. Colors may be used. Markings should be large enough to make



**CHEMICAL
MINEFIELDS**



BOOBY TRAPS



UNEXPLODED BOMB

Figure 3-27. Markings of contaminated or dangerous land areas (STANAG NO. 2002).

ground-to-ground identification of vehicles possible; they are used primarily for easy battlefield recognition. The design and position of these markings are prescribed by the field commander directing their use. They are removed when vehicles are permanently released from the jurisdiction of the commander who prescribed their use.

f. Ground-to-Air Recognition. Equipment for these markings consists of red and yellow fluorescent panels equipped with tie cords. Panel dimensions are approximately 6 feet by 2 feet 3 inches (1.80 m by 0.68 m). Panels are draped on vehicles in a standard, unchanging pattern that differs from the displays prescribed for other recognition purposes (frontlines, targets, etc.). Theater commanders prescribe the arrangement of panels and the conditions under which they will be used.

g. Special. Military police vehicles and other traffic control vehicles are identified, front and rear, with the prescribed markings. Ambulances and other vehicles used exclusively for medical purposes are marked according to the rules of the Geneva Convention. Such markings consist of one red cross or crescent on a square white background painted on the side body panels, roof of body, roof of driver's cab, and rear door(s) or panel.

h. Bomb Disposal Units. Vehicles of bomb disposal units have all fenders painted red.

i. Danger. A red flag flown from any vehicles indicates DANGER.

j. Priority Vehicles. Any vehicle which for any reason (special liaison officer, signal vehicles carrying priority dispatches, damage assessment personnel, etc.) requires priority over all other vehicles may be so marked by any commander concerned. The markings consist of equilateral triangles with red borders and symbols on white backgrounds on the front and rear of the vehicle (fig. 3-28). A single priority sign may be used if visible from both front and rear. The size of a priority sign should be as large as the dimensions of the vehicle permit. The symbol inside the triangle indicates the commander authorizing use of this priority sign. This sign must be removable in order to avoid misuse and is used only on direct orders or the commander concerned.

k. Organization of Columns.

(1) A column of vehicles is a group of at least 10 vehicles moving under a single commander, over the same route, in the same direction.

(2) To facilitate control, large columns may be broken down to serials and march units.

(3) Each column and each organized element must include the following:

(a) A commander whose place in the column varies.

(b) A pace setter in the first vehicle in the first element of a column who leads it and regulates its speed.

(c) A trail officer in the last vehicle of the last element who deals with problems that occur at the tail of the column.

l. Identification of Columns.

(1) Each column is identified in accordance with STANAG NO. 2027, i.e., blue flag on leading vehicle green flag on last vehicle. In addition, when movement is being carried out at night, the leading vehicle shows a blue light and the last vehicle shows a green light. The vehicle of the column commander displays a flag that is bisected by a diagonal line to form two triangles. The upper triangle is white; the lower is black. In areas where vehicles drive on the left side of the highway, the flags are mounted on the right side of the vehicle; otherwise, they are mounted on the left side.

(2) Each column is identified by a number known as a movement number or identification serial number which is allocated at the same time as the movement credit by the authority organizing the movement (*m* below). This number identifies the column during the entire movement.

(3) The number is placed on both sides and, if possible, on the front of all vehicles composing the column so as to be clearly visible. It is composed of the following:

(a) Two figures indicating the day of the month on which the movement is due to commence.

(b) Three or four letters indicating the authority organizing the movement. The first two letters are the national symbols shown in STANAG NO. 1059 (Edition No. 2).

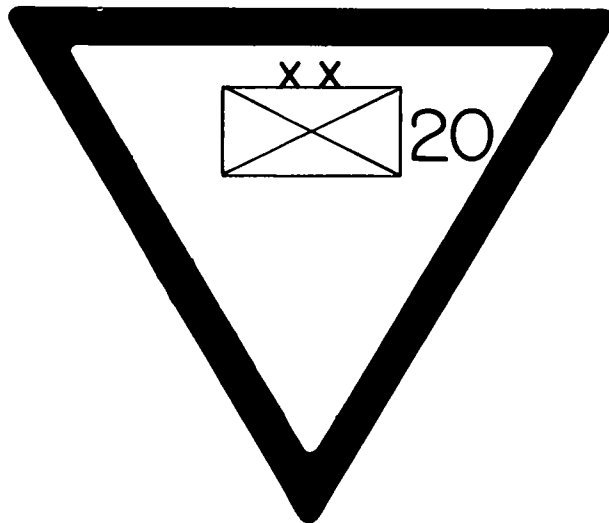


Figure 3-28. Vehicle priority sign.

(c) Two figures indicating the serial number allocated by the authority responsible for the movement. For example, 03-USV-08 indicates that column No. 8, composed of V corps vehicles, will be moved by United States authority on the third day of the current month.

(d) The elements of a column may be identified by adding a letter behind the movement number.

m. Movement Credit.

(1) A movement credit is the time allocated to one or more vehicles to move over a supervised, dispatch, or reserved route.

(2) Besides the allocation of a movement number or identification serial number, a movement credit includes the indication of times at which the first and last vehicle of a column are scheduled to pass—

(a) The entry point—where the column enters the controlled route.

(b) The exit point—where the column leaves the controlled route.

3-51. Preparation of Vehicles for Air Movement

a. Units which must be ready for immediate movement by air should make preparations well in advance to avoid delays in the loading of vehicles into the transporting aircraft. Essential items of information that must be available are—

(1) Weight of vehicle with load.

(2) Dimensions of vehicle.

(3) Center of gravity of loaded vehicle.

b. The dimensions of the vehicle may be obtained from the vehicle technical manual. Since unit equipment is loaded on vehicles for air shipment in accordance with a prescribed loading plan, the center of gravity has to be computed for each vehicle. Actual weighing and computation may be made during loading plan tests. After a vehicle has been loaded in accordance with the unit loading plan, its center of gravity should be marked on the exterior of the vehicle with crayon or waterproof tape.

c. Figure 3-29 illustrates method of determining the weight and center of gravity location of single- and multi-unit vehicles.

3-52. Vehicle Weight and Dimension Card

The NATO Armed Forces have agreed to adopt for the transportation of their vehicles the card shown in figure 3-30.

a. The front is printed in white on a black background. (When printed forms are not immediately available, a substitute card printed and completed in black on a white background is used.)

b. The border of the front is gummed so as to facilitate affixing to windshields.

c. The card is printed in both the official NATO languages (English and French) and in the language of the country of origin if other than English or French.

d. The size of the card is 9½ inches (24 cm) × 7¼ inches (18 cm).

e. Instructions for using the card are shown on the reverse side of each card (fig. 3-30).

3-53. Transportation Motor Pool Layout and Facilities (Fig. 3-31)

The basic layout of motor pools varies depending on space and existing conditions. The typical motor pool should include the facilities described below. In cases of new construction, the use of a single structure is advocated. This promotes substantial economies in construction costs and operations.

a. Office. The motor pool office should be located in the motor pool operations area.

b. Dispatch Office. All vehicular operations are controlled through this office. If at all possible, it should be located at the exit of the motor pool, thereby allowing the dispatcher to visibly check vehicles leaving the parking area.

c. Driver's Room. For convenience, the driver's room should be located in the vicinity of the dispatch office and for orderly operation, separate from the main dispatch office.

d. Emergency Repair Facility. This facility performs minor and emergency repairs that are not serious enough to warrant removal of the vehicle from operation. It is usually located in a section of the general repair shop or at the POL point.

e. Vehicle Washing Facilities. Such facilities should be available for use under all weather conditions. Facilities should be so located that

drainage is away from parking areas and buildings. The use of automatic washing facilities should be considered when feasible.

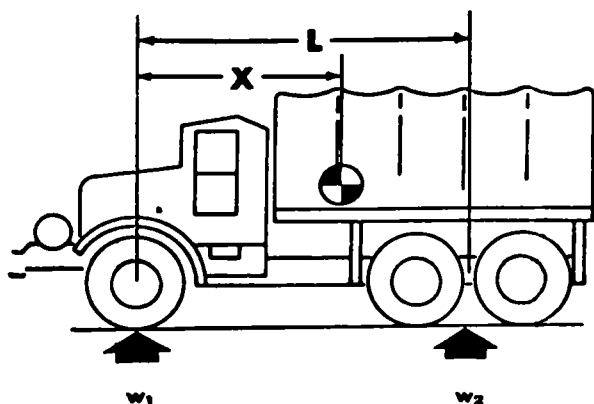
f. Preventive Maintenance and General Repair Shop. The number of vehicles to be serviced is a deciding factor in the type of shop used. The primary function of the shop should be the accomplishment of regularly scheduled preventive maintenance, lubrication, and general repair activities.

g. Allied Trade Shops. Shops for spot painting, minor body work, carpentry, and welding are set up at the motor pool. Because of the fire hazard existing in some trade shops, segregation of this facility is often required. For

example, painting and welding activities should not be performed in close proximity.

h. Supply and Parts Room. This facility is centrally located within the main shop building to provide easy access to parts and tools. Parts, bins, tool racks, and an appropriate issue counter should be provided.

i. Public Address System. A public address system facilitates control of the motor pool or parking area. Interoffice communication between the dispatch office and key locations within the pool area eliminates many unnecessary, time-consuming trips and contributes to more orderly execution of assigned duties.



$$X = \frac{L w_2}{W}$$

WHERE

X = Distance from front axle to unit center-of-gravity location

L = Wheelbase

w₁ = Front axle load

w₂ = Rear axle load

W = Total weight of unit

TO LOCATE CARGO UNIT CENTER OF GRAVITY, DETERMINE X

1. Determine axle loads by weighing all axles (w₁ and w₂).

Note

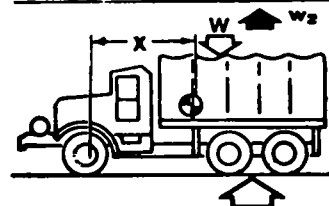
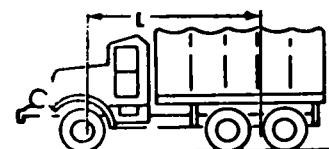
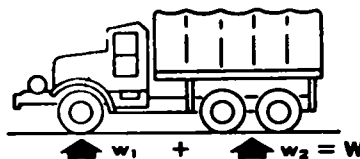
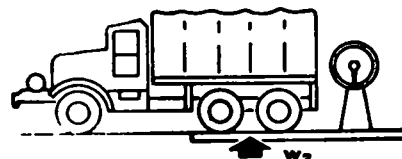
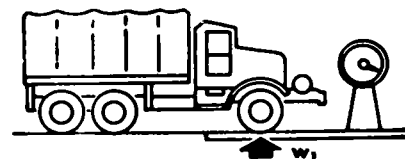
Vehicle must be level when weighing.

2. Determine total weight of unit (W) by adding axle loads (w₁ and w₂).

3. Determine wheelbase (L).

4. Determine rear axle moment about front axle by multiplying rear axle load (w₂) by wheelbase (L).

5. Determine center-of-gravity distance from front axle (X) by dividing rear axle moment by total weight (W).



REAR AXLE MOMENT

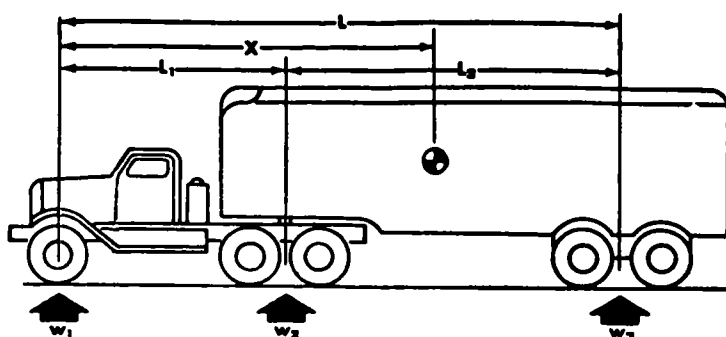
VEHICLES

Figure 3-29. Determining cargo unit center of gravity, single-unit vehicle.

$$X = \frac{L_1 w_2 + L w_3}{W}$$

WHERE

- X = Distance from front axle to unit center-of-gravity location
 w_1 = Front axle load
 L_1 = Tractor wheelbase
 w_2 = Tractor rear axle load
 L_2 = Trailer wheelbase
 w_3 = Trailer axle load
 L = Total wheelbase of unit
 W = Total weight of unit



TO LOCATE CARGO UNIT CENTER OF GRAVITY, DETERMINE X

1. Determine axle loads by weighing all axles (w_1 , w_2 , and w_3).

Note

Vehicle must be level when weighing

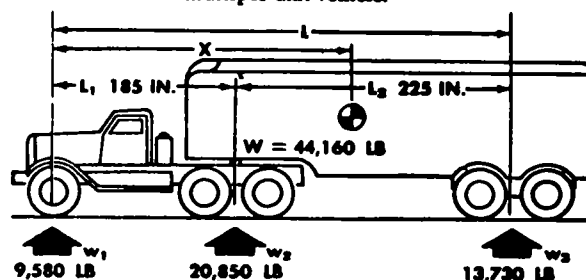
2. Determine total weight of unit (W) by adding all axle loads.
3. Determine tractor wheelbase (L_1) and trailer wheelbase (L_2).
4. Determine total wheelbase of unit (L).
5. Determine tractor rear axle moment about front axle by multiplying tractor wheelbase (L_1) by tractor rear axle load (w_2).
6. Determine trailer axle moment by multiplying total wheelbase (L) by trailer axle load (w_3).
7. Determine total moment about front axle by adding trailer axle moment and tractor rear axle moment.
8. Determine center-of-gravity distance from front axle (X) by dividing total moment by total weight (W).

Notes:

As an aid to load planning, it may be desirable to know relationship of vehicle center of gravity to vehicle extremities. To determine distance from front bumper to center of gravity, add distance between front bumper and front axle to value determined in step 8. To determine distance between aft end of vehicle and center of gravity, subtract value determined in step 8 from distance between front axle and aft end of vehicle.

SAMPLE PROBLEM

GIVEN: A multiple-unit vehicle.



PROBLEM: Determine center-of-gravity location.

SOLUTION:

1. $w_1 = 9,580$ pounds
 $w_2 = 20,850$ pounds
 $w_3 = 13,730$ pounds
2. $W = 9,580 + 20,850 + 13,730 = 44,160$ pounds
3. $L_1 = 185$ inches
 $L_2 = 225$ inches
4. $L = 185 + 225 = 410$ inches
5. $185 \times 20,850 = 3,857,250$
6. $410 \times 13,730 = 5,629,300$
7. $3,857,250 + 5,629,300 = 9,486,550$
8. $9,486,550 \div 44,160 = 214.8$

CONCLUSION:

Cargo unit center of gravity is located 214.8 inches aft of front axle.

MULTIPLE-UNIT VEHICLES

Figure 3-29—Continued.

(Example--Front)

VEHICLE WEIGHT AND DIMENSION CARD

FICHE DE DIMENSIONS ET DE POIDS DU VEHICULE

----- (3d language/3ème langue)

State unit of measure used.
Préciser l'unité de mesure utilisée.
----- (3d language/3ème langue).

WEIGHT
POIDS

----- (3d language/3ème langue)

LENGTH
LONGUEUR

----- (3d language/3ème langue)

BREADTH
LARGEUR

----- (3d language/3ème langue)

HEIGHT
HAUTEUR

----- (3d language/3ème langue)

GROUND PRESSURE OR MAXIMUM AXLE
LOAD

PRESSION UNITAIRE OU POIDS DE
L'ESSIEU LE PLUS CHARGE

----- (3d language/3ème langue)

Figure 3-30. Vehicle weight and dimension card.

(Example--Back)

Directions for Use

Mode d'emploi

1. This card is designed to display vehicle laden weight and dimensions to all concerned with loading it on any means of transport, e.g., to an aircraft, ship, etc.
1. Cette fiche est destinée à indiquer le poids on charge et les dimensions d'un véhicule à tous ceux qui peuvent être responsables de son chargement sur n'importe quel mode de transport, par exemple: avion, navire, etc.
1. _____ (3d language/3ème langue) _____
2. Accurate weight and dimensions will be printed in chalk by the unit or depot preparing a vehicle for movement. This card will then be fixed inside the windscreen on the passenger's side. On tanks or other vehicles without windscreens, this card will be fixed on a suitable surface on the opposite side of the vehicle from the driver's seat, where it can be easily seen. If possible, it should be protected from inclement weather.
2. Le poids et les dimensions exacts seront indiqués à la craie, en lettres majuscules, par l'unité ou le dépôt préparant le véhicule en vue de son transport. Cette fiche sers ensuite apposee à l'intérieur du pare-brise, du côté du passager. Dans le cas des chars ou autres véhicules sans pare-brise, la fiche sera apposée sur une surface appropriée sur le côté du véhicule opposé à celui du siège du conducteur et dans une position facilement visible. Si possible, le fiche doit être à l'abri des intempéries.
2. _____ (3d language/3ème langue) _____
3. This is a NATO form and whoever "chalks in" the weights and dimensions should use his country's normal system of weight and measurement.
3. Cette fiche est un formulaire OTAN et la personne chargée d'inscrire la craie le poids et les dimensions du véhicule doit utiliser le système normal de poids et mesures de son propre pays.
3. _____ (3d language/3ème langue) _____

Figure 3-30—Continued.

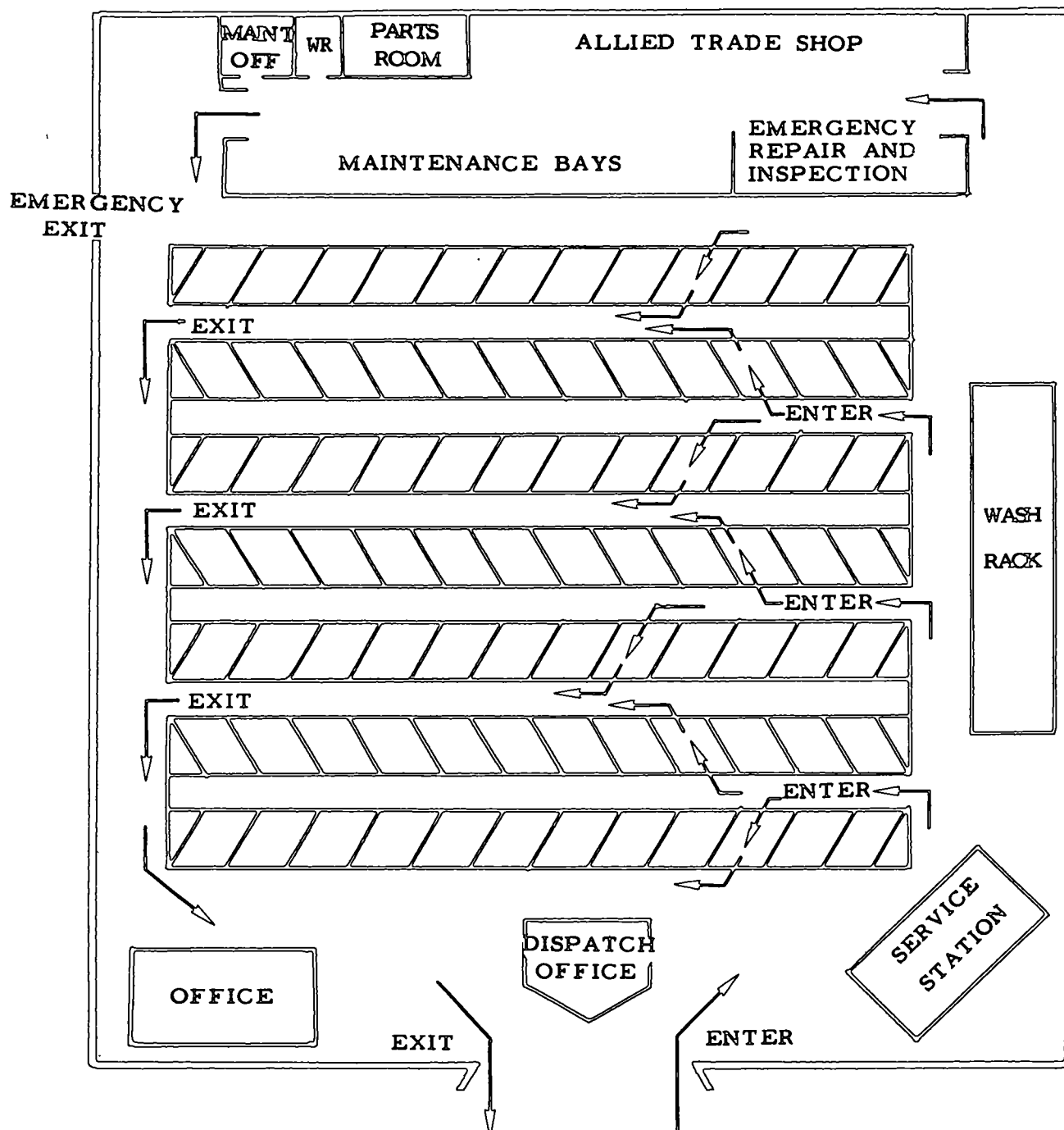


Figure 3-31. Motor pool parking space.

★CHAPTER 4

RAIL

Section I. ORGANIZATION

4-1. General

a. The transportation railway service is the overall organization of rail units assigned or attached to the senior transportation organization, which is normally a transportation command, theater army support command (TASCOM). It is composed of railway supervisory, operating, and maintenance units as required to operate trains, to maintain rail lines of communication, and to perform organizational and direct support maintenance of locomotives and rolling stock. These units are discussed in detail in FM 55-20 and TM 55-206.

b. The operation of military railways may be accomplished in three phases:

(1) *Phase I.* This phase is conducted exclusively by military railway personnel.

(2) *Phase II.* During this phase, railway lines are operated and maintained by military railway personnel augmented with and assisted by local civilian railway personnel. This phase is under direct military supervision.

(3) *Phase III.* This phase is initiated as soon as local conditions permit. Under this arrangement, local national civilian railway personnel operate and maintain railway lines under the direction and supervision of the highest military railway echelon in the theater, thus releasing railway unit personnel for other duties.

4-2. Organization of Transportation Railway Service (TRS) (Fig 4-1)

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Headquarters and headquarters company, transportation railway brigade.	55-201	To command and provide operational planning, supervision, coordination, and control of the activities of transportation railway groups.	To a theater support command, normally attached to a headquarters and headquarters company, transportation command.	Provides command and supervision of three or more transportation railway groups, TOE 55-202.
Headquarters and headquarters company, transportation railway group.	55-202	To command, administer, and supervise the operation of railway battalions and attached supporting units.	To the transportation command, theater army support command (TASCOM): may be attached to the transportation railway brigade or operate directly under the transportation command, TASCOM.	Provides command and supervision for from two to six transportation railway battalions and transportation railway maintenance units as required.
Transportation railway battalion-----	*55-225	To operate and maintain a railway division in a theater of operations.	To transportation railway group-----	a. During phase I operations (complete military operation of the railway): operates 40 locomotives per day in road and yard service over approximately 90 to 150 miles of railroad; b. Operates a railway classification yard for the formation of trains; c. Adequate to inspect, condition, and make organizational and direct support maintenance on approximately 40 locomotives and 800 railroad cars; performs running inspections of approximately 2,000 railroad cars per day. Also repairs tools and mechanical equipment of all companies within the battalion; d. Inspects and maintains approximately 90 to 150 miles of railway right-of-way (tracks); and available railway signals, electrical communications, structures, bridges and buildings located within a railway division; and e. Inspects and repairs wire communications and signal appurtenances used for train movements.
Headquarters and headquarters company, transportation railway battalion.	55-226	To command, administer, and supervise the operation of railway and attached supporting units of the transportation railway battalion.	Organic to the transportation railway battalion.	a. Provides command, staff planning, administration, control, and supervision of operations of the transportation railway battalion and assigned and attached units;

*TOE 55-225 will be deleted upon publication of the "H" series TOE.

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Transportation railway engineering company.	*55-227	To maintain and repair railway track, bridges, buildings, and railway signals and communications within a railway division.	Organic to transportation railway battalion.	b. Dispatches all trains operated by the battalion and supervises on-line operations; and operates railway stations and signal towers which are the responsibility of the battalion; c. Provides messing facilities and organizational motor maintenance facilities for assigned units of the battalion.
Transportation railway equipment maintenance company.	55-228	To inspect, service, and make running repairs to diesel-electric locomotives and rolling stock.	Organic to transportation railway battalion.	a. Services and makes running repairs to approximately 40 diesel-electric locomotives and 800 railway cars on an around-the-clock basis; b. Performs running inspection for 2,000 railway cars daily; c. Performs light repairs to tools and limited repairs to special mechanical equipment within the battalion.
Transportation train operating company.	55-229	To provide road and yard personnel for the operation of railway locomotives and trains.	Organic to transportation railway battalion.	At full strength, provides 40 traincrews daily for road and/or terminal operation, including the performance of incidental switching service for 90 to 150 miles of railroad on an around-the-clock basis.
<i>Note.</i> These TOE will be assigned upon publication under the H-series as follows: to the Transportation Command (TASCOM) and further attached to a transportation railway group or to a headquarters and a transportation railway battalion as appropriate.				
Transportation electric power transmission company.	55-217	To maintain and repair electric power transmission facilities for the transportation railway battalion.	To the transportation command (TASCOM) and normally is attached to a transportation railway battalion where electric motive power is operated by an electrified catenary when required and authorized by Department of the Army.	Maintains and repairs electric power transmission facilities, including substations and catenary for 200 miles of electrified railway, including sidetracks, passing tracks, and yard tracks.
**Diesel-electric locomotive repair company.	55-247	To perform general support maintenance of diesel-electric locomotives and railway cranes.	To the maintenance battalion of a material command field depot. May be attached to a transportation railway group.	Performs general support maintenance in support of 200 diesel-electric locomotive units and/or railway cranes with a maximum capability of 25 locomotives and/or cranes per month.

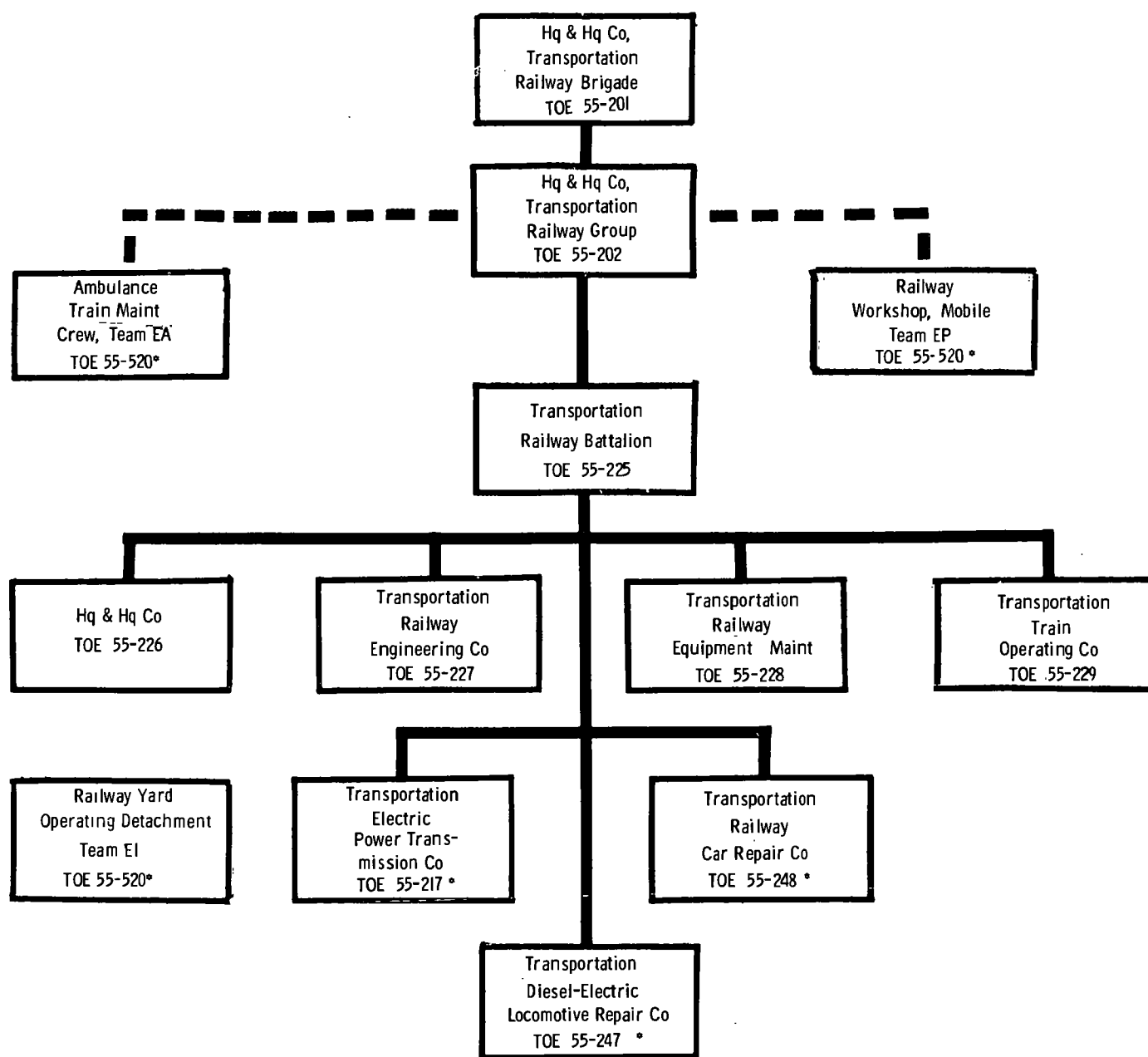
*The communications railway signal platoon will be transferred to TOE 55-226 under the H series TOE.

**These units are dependent upon adjacent or colocated units for organizational maintenance of assigned motor vehicles, and upon an adjacent or supporting personnel services unit for personnel administrative services.

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
*Railway car repair company (General Support).	55-248	a. To perform general support maintenance on railway equipment; b. To supply repair parts for organizational and direct support maintenance of railway equipment when sources of supply are not otherwise assigned in an area of operation.	To the maintenance battalion of a material command field depot. May be attached to a transportation railway group.	a. Performs general support maintenance involving stripping, fabricating, assembling, erecting, and painting in support of 2,500 railway cars; b. Dismantling, assembling, and repairing boxcars, flatcars, gondola cars, tank cars, hospital cars, passenger cars, and special-purpose cars, to include body and running gear capable of performing general support maintenance on 600 railway cars per month; c. Receives, stores, and issues 8,000 line items of railway supplies and spare parts per month in support of four to six railway battalions.
Team EA, ambulance train maintenance detachment (DS).	55-520	To perform running repairs on ambulance train railway cars.	To the senior transportation railway unit in a theater of operations.	Performs running repairs on one ambulance train.
Team EI, railway yard operating detachment.	55-520	To operate a railway yard-----	To a transportation railway battalion or comparable unit.	a. Operates a railroad yard on a 24-hour basis when yard train crews are provided and when not more than two receiving and classification yards, including humps, etc., are to be operated. b. Inspects and performs running repairs on rolling stock transiting the yard; and c. Inspects and, as necessary, adjusts or secures loads on cars passing through the yard.
Team EL, railway workshop mobile detachment (DS).	55-520	To perform direct support maintenance of diesel-electric locomotives and rolling stock in areas where static facilities are inadequate or nonexistent.	To headquarters and headquarters company, transportation railway group or to a transportation railway battalion or comparable unit.	Performs the following functions on a 24-hour basis: a. Inspecting and performing direct support maintenance on 20 diesel-electric locomotives and 100 railway cars; and b. Assembling railway equipment.

*These units are dependent upon adjacent or collocated units for organizational maintenance of assigned motor vehicles, and upon an adjacent or supporting personnel services unit for personnel administrative services.

Note. Additional teams EB, EC, ED, EE, EF, EG, EH, EJ, EK, EM, and EN authorized by TOE 55-520 for various maintenance and operating functions not discussed in detail herein.



*Assigned as required

Figure 4-1. Organization of the transportation railway service.

Section II. EQUIPMENT

4-3. Whyte Classification System of Locomotives

The locomotives described in this section are classified according to the Whyte system, which classifies locomotives according to the arrangement of their wheels. A series of numerals separated by hyphens are used to designate the total number of wheels on the axle of each type of locomotive truck—the front (leading) truck, driving wheel

group, and rear (trailing) truck, respectively. On steam locomotives, the figures always describe the locomotive's wheels from front to rear; the wheels of the locomotive tender are not counted. For example, the classification of 2-8-2 indicates the locomotive has one pair of leading wheels, four pairs of coupled driving wheels, and one pair of trailing wheels. The absence of leading and/or trailing wheels is always denoted by a zero; thus, a 2-8-0 locomotive has no trailing wheels. Diesel

locomotives are also classified by this system; figures such as 0-6-6-0 indicate no leading or trailing wheels and two sets of three driving axles each, or a total of 12 driving wheels. The classification commonly used in Europe and other parts of the world, however, classifies a diesel or electric locomotive by letters and figures. A diesel 0-4-4-0 is classified B-B; a 0-6-6-0 is designated

C-C, etc. Idler wheels (those which exert no tractive effort) and leading and trailing wheels are designated with numbers. A single-unit locomotive with two six-wheel trucks where the center pair are idlers would be designated as A1A-A1A. An electric locomotive four-wheel leading and trailing trucks and six driving wheels would be designated 2-C/C-2.

4-4. Characteristics of Railway Equipment

a. Locomotives, Diesel-Electric.

Type	Gage (in.)	Weight (lb)	Length over couplers	Extreme width	Extreme height	Tractive force (lb)		Horsepower	Curvature min radius (ft)	Fuel capacity (gal.)
						Starting at 30 percent adhesion	Continuous			
131-ton, 0-6-6-0, domestic and foreign svc. FSN 2210-554-0786	56½	262,900	55'	10'0"	14'0"	75,700	37,850 at 10 mph	1,000	231	1,600
127-ton, 0-6-6-0, domestic and foreign svc. FSN 2210-270-1354	56½	261,100	55'	10'0"	14'0"	75,700	37,850 at 10 mph	1,000	231	1,600
120-ton, 0-6-6-0, domestic and foreign svc. FSN 2210-814-5291	56½, 60	240,000	57'5"	9'8"	13'6"	73,000	37,000 at 10 mph	1,600	193	1,600
FSN 2210-815-3521, w/generator	63, 66	245,000 w/steam generator								800 w/steam generator
120-ton, 0-6-6-0, domestic and foreign svc. FSN 2210-819-4319	56½, 60, 63, 66	240,000 245,000 w/steam generator	56'9"	9'7"	13'5"	72,000	36,000 at 10 mph	1,600	193	1,600 800 w/steam generator
120-ton, 0-4-4-0, domestic svc	56½	240,000	55'9"	10'3"	14'6"	75,000	40,000 at 11 mph	1,500	150	800
FSN 2210-554-0785										
120-ton, 0-4-4-0, domestic svc	56½	246,000	48'10"	10'2"	14'6"	73,000	36,000 at 10 mph	1,200	100	750
FSN 2210-262-0751										
115-ton, 0-4-4-0, domestic svc	56½	230,000	45'6"	10'0"	14'6"	69,000	34,000 at 15 mph	1,000	50	635
FSN 2210-112-8508										
100-ton, 0-4-4-0, domestic svc	56½	199,000	44'6"	10'0"	14'4"	59,700	28,750 at 10 mph	660	50	635
FSN 2210-819-9320										
100-ton, 0-4-4-0, domestic svc	56½	200,000	44'5"	10'0"	14'7"	69,700	35,000 at 10 mph	700	100	600
FSN 2210-371-7535										
80-ton, 0-4-4-0, domestic svc	56½	161,000	36'10"	9'6"	13'7"	48,000	24,000 at 10 mph	500	75	400
FSN 2210-820-5451										
80-ton, 0-4-4-0, domestic svc	56½	161,000	36'10"	9'6"	13'7"	48,000	24,000 at 10 mph	470	75	400
FSN 2210-804-3614										
80-ton, 0-4-4-0, domestic svc	56½	161,600	41'0"	9'6"	13'4"	48,000	21,000 at 5.2 mph	550	75	400
FSN 2210-804-3615										
65-ton, 0-4-4-0, domestic svc	56½	130,000	34'0"	10'1"	13'5"	39,000	19,500 at 10 mph	400	75	250
FSN 2210-819-9314										
60-ton, 0-4-4-0, domestic and foreign svc. FSN 2210-819-9318	56½, 60, 63, 66	122,000	38'11" (Type E) 39'3" (Willison)	9'6"	13'4"	36,000	15,680 at 7.78 mph	500	75	500
45-ton, 0-4-4-0, domestic and foreign svc. FSN 2210-529-9038	56½	90,000	33'6"	9'7"	12'0"	27,000	12,000 at 6 mph	380	75	250

Type	Gage (in.)	Weight (lb)	Length over couplers	Extreme width	Extreme height	Tractive force (lb)		Horsepower	Curvature min radius (ft)	Fuel capacity (gal.)
						Starting at 30 percent adhesion	Continuous			
45-ton, 0-4-4-0, domestic svc (side rod drive). FSN 2210-831-1135	56½	90,000	28'4"	9'6"	12'0"	27,000	13,500 at 6.2 mph	300	50	165
44-ton, 0-4-4-0, domestic svc..... FSN 2210-804-3610	56½	91,270	33'10"	9'4"	13'3"	26,400	11,000 at 9 mph	380	75	250
44-ton, 0-4-4-0, domestic svc..... FSN 2210-820-5602	56½	89,000	33'5"	10'1"	13'3"	26,400	13,000 at 7.1 mph	380	50	250
25-ton, 0-4-0, domestic svc..... FSN 2210-834-3202	56½	50,000	16'1"	8'7"	10'4"	15,000	6,200 at 6.2 mph	150	50	75

b. Locomotive Cranes.

Type	Gage (in.)	Weight (lb)	Length over couplers	Extreme height	Extreme width	Boom (ft) length	Reach radius and capacity	
							Main hoist	Aux hoist
Locomotive, steam, wrecking, 75-ton, broad gage, domestic and foreign svc. FSN 2230-174-9138	56½, 60, 63, 66	191,000	30'10"	17'10"	10'4"	25-2 piece curved	16' 75-ton 25' 34-ton	25' 10-ton 30' 8-ton
Locomotive, crane, diesel, mechanical, 150-ton, domestic svc. FSN 2230-554-4545	56½	291,700	31'0"	15'6"	10'4"	28-2 piece straight	28' 67-ton	
Locomotive, diesel, electrical, 40-ton, broad gage, domestic and foreign svc. FSN 2230-554-2728	56½, 60 63, 66	221,500	36'1"	13'6"	10'4"	50-2 piece straight	12' 40-ton 50' 6¾-ton	
Locomotive, diesel, electric, 40-ton, domestic svc.... FSN 2230-434-6649	56½	220,000	29'4"	15'1"	10'6"	50-2 piece straight	12' 40-ton 50' 6¾-ton	
Locomotive, diesel, mechanical, 25-ton, broad gage, domestic and foreign svc. FSN 2230-174-9130	56½, 60 63, 66	148,000	27'7"	13'0"	8'6"	50-2 piece straight	12' 25-ton 50' 4-ton	
Locomotive, diesel, mechanical, 25-ton, narrow gage, foreign svc. FSN 2230-202-2111	36, 39¾ 42	152,000	32'6"	12'0"	8'6"	40-2 piece straight	12' 25-ton 40' 6-ton	
Locomotive, diesel, mechanical, 25-ton, domestic svc.. FSN 2230-809-9863	56½	155,000	30'0"	15'2"	10'8"	50-2 piece straight	12' 25-ton 50' 4-ton	
Locomotive, diesel, mechanical, 35-ton, domestic svc.. FSN 2230-803-8571	56½	167,000	30'0"	15'7"	10'4"	50-2 piece straight	12' 35-ton 50' 5-ton	

c. Locomotive, Gasoline-Mechanical and Diesel-Mechanical.

Type	Gage (in.)	Weight (lb)	Horsepower (total engine)	Curvature, min radius (ft)	Fuel capacity (gal.)
10-ton, single-engine, 0-4-0, domestic service.....	56½	20,000	100	75	30 (diesel)

d. Railway Maintenance Motor Cars.

Type	Gage (in.)	Weight (lb)	Length (in.)	Width (in.)	Height (in.)	Capacity	Horsepower	Fuel capacity
Gasoline mechanical, 4 wheels, solid drawbar couplers, closed cab with handbrake. FSN 2230-230-2765	56½	2,950	112	65	58 excluding cab	8-man	62.6	8 gal
Gasoline mechanical, 4 wheels, solid drawbar couplers, open body with handbrake. FSN 2230-926-1053	56½	1,700	103	65	50	10-man	62.6	8 gal

e. Boxcars.

Type	Gage (in.)	Capacity		Inside dimension			Door dimensions	Light weight (ston)
		(lb)	(cu ft)	Length	Width	Height		
8W, domestic service.....	56½	100,000	3,975	50'6"	9'3"	10'6"	10' wide, clear opening 8' high, clear opening	23
8W, broad gage, foreign service.....	56½, 60, 63, 66	80,000	2,520	40'6"	8'6"	6'5⅝"	8'3¼" high 6'8¾" wide	18.5

f. Open-Top Cars.

(1) Flatcars.

Type	Gage (in.)	Normal capacity (lb) ¹	Platform length ¹	Platform width ¹	Platform height above rail	Light weight (ston)
8W, narrow gage, foreign service.....	36, 39⅜, 42	60,000	34'8½"	7'2"	3'7"	10.9
12W, domestic service.....	56½	200,000	54'	10'6½"	4'1¼"	35
8W, domestic service.....	56½	140,000	49'11½"	10'3¼"	3'8½"	27
12W, broad gage, foreign service, 80-ton.....	56½, 60, 63, 66	160,000	46'4"	9'8"	4'2⅞"	35.3
12W, domestic service (passenger train service).....	56½	200,000	54'	10'6¼"	4'5⅜"	
8W, domestic service.....	56½	100,000	43'3"	10'6"	3'8"	25.5
8W, broad gage, foreign service.....	56½, 60, 63, 66	80,000	40'9"	8'7¼"	3'6½⅞"	14.5
8W, broad gage, depressed center, foreign service.....	56½, 60, 63, 66	140,000	50'7"	9'8"	.....	41.5

¹ To determine vehicle-carrying capacity of flatcars, use these three columns in conjunction with the information contained in chapter 3. Determine first the number of vehicles by type that will fit on the flatcar bed. Then check their combined weights (including any cargo in the vehicles) against the weight capacity of the car. Either the platform dimensions of the flatcar or its weight-carrying capacity is the controlling factor. Side sills of flatcars must be considered in determining ability to carry tracked vehicles such as tanks, where the total loaded weight is resting on the outer edge of the car deck.

(2) Gondolas.

Type	Gage (in.)	(lb)	(cu ft)	Inside dimensions			Light weight (ston)
				Length	Width	Height	
High side, 8W, narrow gage, foreign service.....	36, 39 $\frac{3}{8}$, 42	60,000	940	34'5"	6'10 $\frac{1}{2}$ "	4'	13
Low side, 8W, narrow gage, foreign service.....	36, 39 $\frac{3}{8}$, 42	60,000	356	34'6"	6'10 $\frac{1}{2}$ "	1'6"	12.1
High side, 8W, broad gage, foreign service.....	56 $\frac{1}{2}$	80,000	1,680	40'	8'3 $\frac{3}{4}$ "	4'	18
Low side, 8W, broad gage, foreign service.....	56 $\frac{1}{2}$, 60, 63, 66	80,000	500	40'4 $\frac{1}{2}$ "	8'3 $\frac{1}{4}$ "	1'6"	16
Low side, 8W, drop ends, domestic service.....	56 $\frac{1}{2}$	100,000	1,184	41'6"	9'6 $\frac{1}{8}$ "	3'	23
High side, std gage, domestic service.....	56 $\frac{1}{2}$	100,000	1,580	41'6"	9'6"	4'6"	25

(3) Hopper cars.

Type	Gage (in.)	Normal capacity (lb)	Length	Width	Height
8W, domestic service.....	56 $\frac{1}{2}$	100,000	33'	9'5 $\frac{1}{2}$ "	9'7"

g. Tank Cars.

Type	Gage (in.)	Length over tank heads	Normal capacity (gal.) ¹	Inside diameter (in.)		Light weight (ston)
				Tank ²	Dome	
Nickel-clad, ICC-103-AW, 8W domestic service.....	56 $\frac{1}{2}$	31'11"	7,500	78, approx	45	
ICC-103, ICC-103-W, 8W, domestic service.....	56 $\frac{1}{2}$	34', approx	10,000	87, approx	59 $\frac{3}{8}$, approx	
Caustic soda, ICC-103-W, 8W, domestic service.....	56 $\frac{1}{2}$	34', approx	10,000	88, approx	64	
Petroleum, 8W, narrow gage, foreign service.....	36, 38 $\frac{3}{8}$, 42	38'4 $\frac{1}{8}$ "	6,000	62 $\frac{1}{2}$	54	16
Petroleum, 8W, broad gage, foreign service.....	56 $\frac{1}{2}$, 60, 63, 66	38'5 $\frac{3}{8}$ "	10,000	80 $\frac{3}{4}$	66 $\frac{1}{2}$	19
Nitric acid, ICC-103-W, 8W, domestic service.....	56 $\frac{1}{2}$	33'7 $\frac{1}{2}$ "	7,800	78, approx	35 $\frac{3}{8}$	
Phosphorus, ICC-103-W, 8W, domestic service.....	56 $\frac{1}{2}$	34'8 $\frac{1}{4}$ "	8,000	78, approx	64	
Petroleum, std gage, domestic service.....	56 $\frac{1}{2}$	-----	10,000	-----	-----	23

h. Refrigerator Cars.

Type	Gage (in.)	Normal capacity (lb)	Length inside end lining	Width inside side lining	Ice capacity (lb)	Dimension of doors
8W, disassembled, foreign service.....	56 $\frac{1}{2}$	80,000	38'9 $\frac{1}{2}$ "	6'11"	11,000	4' wide 7' high
8W, disassembled, broad gage, foreign service.....	56 $\frac{1}{2}$, 60, 63, 66	80,000	32' $\frac{1}{2}$ "	7'8", approx	11,000	4' wide 7' high
8W, mechanical, foreign service.....	56 $\frac{1}{2}$, 60, 63, 66	80,000	40'9" equipment compartment	7'6", approx	None	6' wide 7' high

¹ Specific gravity of a liquid should be checked before it is loaded to avoid exceeding weight capacity of car.² See paragraph 7-24 for liquid volume in partially filled tank cars.

i. Special-Purpose Cars.

Type	Gage (in.)	Weight (lb)		Over end sills		Height above rail	Remarks
		Light	Loaded	Length	Width		
Car, amb unit, 8W, domestic service----	56½	157,000	167,300	78'11"	10'	13'6"	Capacity: 27 patients, 6 corpsmen, 1 nurse, 1 doctor.
Car, guard, domestic service-----	56½	92,740	99,300	57'	9'1"	14'2½"	Airconditioned, shower, toilet, kitchen. 2 sleeping compartments.
Car, kitchen, troop/amb train, 8W, domestic service.	56½	100,160	-----	* 54'2½"	9'5¾"	13'6"	Width, side door openings: 6'.
Car, kitchen, dining and storage, amb train, 8W, foreign service.	56½, 60, 63, 66	111,400, avg	-----	63'¼"	9'	13'	Seat capacity: 24.
Car, ward, amb train-----	56½, 60, 63, 66	111,400, avg	-----	63'¼"	9'	13'	Berth capacity: 30.
Car, personnel, amb train-----	56½, 60, 63, 66	111,400, avg	-----	63'¼"	9'	13'	Berth capacity: 15 EM, 4 doctors, 2 nurses.

j. Cranes.

Type	Gage (in.)	Weight (lb)	Boom length	Boom height down	Reach radius (main hoist)
Wrecking, steam, 75-ton, broad gage, domestic and foreign service-----	56½, 60, 63, 66	191,000	25' (2-pc, curved)	12'3¾"	16'-75-ton
Locomotive, diesel-mechanical, 150-ton, domestic service-----	56½	291,700	28' (2-pc, straight)	13'6" max.	28'-67-ton
Locomotive, diesel-mechanical, 35-ton, domestic service-----	56½	167,000	50' (2-pc, straight)	13'6" max.	12'-35-ton
Locomotive, diesel-mechanical, 25-ton, broad gage, domestic and foreign service--	56½, 60, 63, 66	148,000	50' (2-pc, straight)	13'6" max.	12'-25-ton
Locomotive, diesel-electrical, 40-ton, broad gage, foreign service-----	56½, 60, 63, 66	221,000	50' (2-pc, straight)	13'6" max.	12'-40-ton
Locomotive, diesel-mechanical, 25-ton, narrow gage, foreign service-----	36, 39¾, 42	152,000	40' (2-pc, straight)	10'10"	12'-25-ton

4-5. Dimensions, Weight, and Capacities of Typical US Freight Cars

There are no standard dimensions for commercial cars. The figures given are for types in common use. The 40-ton stock car comes in many lengths, varying from 35' 7" to 41' 10". All types have similar variations in capacity and dimensions.

Type	Tons	Men (8 sq ft per man and equipment)	Capacity, animals (horses, mules, oxen--avg width, 22 inches)	Cubic feet	Weight empty (tons)	Inside dimensions (ft)		
						Length	Width	Height
Automobile-----	40	45	22	3,100	20	40.5	8.5	9
	50	58	27	4,702	25	50.6	9.2	10.1
Baggage-----					45	60	9.1	8
Box-----	30	38	20	2,750	18	36	8.5	9
	40	43	22	3,100	20	40.5	8.5	9
	50	43	22	3,100	24	40.5	8.5	9
Caboose-----					20	27.5	8.2	7
Diner-----					90	78.5	8.5	8.5
Flat-----	40				18	40	9	
	50				20	45	9	
	70				25	50	9	
Gondola-----	50			1,570	22	40	9.9	4
	70			1,920	25	48	10	4

* Includes couplers.

Type	Tons	Men (8 sq ft per man and equipment)	Capacity, animals (horses, mules, oxen—avg width, 22 inches)	Cubic feet	Weight empty (tons)	Inside dimensions (ft)		
						Length	Width	Height
Refrigerator.....	a 30	-----	-----	2,570	28	40.5	8.2	7.2
	b 40	-----	-----	2,570	30	40.5	8.2	7.5
Stock.....	30	-----	20	2,625	20	36	8.5	8.5
	40	-----	20	3,003	22	40.6	8.6	8.6
Tank.....	c 40	-----	-----	-----	20	33	6.6	-----
	d 50	-----	-----	-----	24	33	7.2	-----

- a Ice capacity, 4 tons.
- b Ice capacity, 5 tons.
- c 8,000 gallons.
- d 10,000 gallons.
- e Diameter.

4-6. Dimensions, Weight, and Capacities of Predominant Types of West German Freight Cars

Type of car	Number of axles	Tare weight (ton)	Capacity		Inside dimensions		Height	Door dimensions		Height of floor above top of rail
			Cubic feet level-full	Short tons	Length	Width		Width	Height	
Boxcar, G-----	2	11.4	1,500	16.5	25'11¾"	8'	7'4⅞ ₁₆	4'11⅛ ₁₆ "	6'6⅛ ₁₆ "	4'⅛ ₁₆ "
Boxcar, GLMHS-50----	2	13.4	2,500	23.1	36'9⅝ ₁₆ "	8'11½ ₁₆ "	9'⅝ ₈ "	6'6⅛ ₁₆ "	6'6⅛ ₁₆ "	4'9 ₁₆ "
Boxcar, GM-30-----	2	12.7	1,700	23.1	24'10"	8'10"	31'4"	5'6"	6'	Not available
Boxcar, GMS-54-----	2	12.6	2,100	23.1	30'5⅛ ₁₆ "	8'8⅛ ₁₆ "	8'9½"	5'10⅓ ₁₆ "	6'7⅛ ₈ "	4'⅛ ₁₆ "
Boxcar, KMMKS-51----	2	12.5	1,420	30.8	28'8⅓ ₁₆ "	9'⅝ ₈ "	5'6½ ₁₆ "	5'10⅓ ₁₆ "	4'10⅝ ₈ "	4'1⅞ ₁₆ "
Boxcar, KMM8KS-58----	2	14.3	1,800	29.7	28'8⅞ ₁₆ "	8'11½ ₁₆ "	7'1⅝ ₁₆ "	12'8¾"	6'6⅛ ₁₆ "	4'⅛ ₁₆ "
Gondola, X-05 (low side).	2	Not available	320	23.1	25'7"	8'7"	1'4"	-----	-----	Not available
Gondola, XLM-57 (low side).	2	8.4	330	23.1	29'7"	8'6"	1'4"	-----	-----	4'
Gondola, OMM-37 (high side).	2	9.7	1,210	24.6	27'7"	9'	4'10"	-----	-----	4'
Gondola, OMM-52 (high side).	2	11.0	1,200	28.6	28'	8'	4'10"	-----	-----	4'
Gondola, OMM-55 (high side).	2	11.0	1,200	27.5	28'8⅞ ₁₆ "	9'⅜ ₈ "	4'11⅛ ₁₆ "	5'10½"	-----	4'⅞ ₈ "
Gondola, OMM-53 (high side).	2	12.1	1,200	27.5	28'	8'9"	4'10"	-----	-----	4'
Gondola, OMM-33 (high side).	2	11.5	1,260	27.0	28'7⅝ ₁₆ "	9'⅞ ₁₆ "	5'1"	4'11⅛ ₁₆ "	-----	4'⅝ ₈ "
Flatcar, R-10 ^a -----	2	10.6	-----	16.5	33'2⅝ ₁₆ "	8'9"	-----	-----	-----	4'
Flatcar, RM-31 ^a -----	2	14.3	-----	22.1	34'11⅓ ₁₆ "	8'6⅝ ₁₆ "	-----	-----	-----	4'1⅞ ₈ "
Flatcar, RMM-33 ^a -----	2	11.4	-----	27.0	34'8⅜ ₈ "	9'2¼"	-----	-----	-----	4'1¼"
Flatcar, RLMS-56 ^a ----	2	14.0	-----	25.3	40'	8'11"	-----	-----	-----	4'
Flatcar, SM-14 ^a -----	2	11.9	-----	23.1	41'6"	8'9"	-----	-----	-----	Not available
Flatcar, SS-15 ^a -----	4	21.5	-----	40.2	48'2"	8'9"	-----	-----	-----	Not available
Flatcar, SSLMA-44-----	4	22.7	-----	44.1	59'27 ₁₆ "	9'¼"	-----	-----	-----	4'5¾"
Flatcar, SSLMAS-53----	4	26.3	-----	61.6	60'8⅝ ₁₆ "	8'11⅓ ₁₆ "	-----	-----	-----	4'6½"

Flatcar, SSKM-49-----	4	17.1	-----	55.1	40'8 $\frac{3}{4}$ "	8'5 $\frac{15}{16}$ "	-----	4'3 $\frac{9}{16}$ "
Flatcar, USA-owned-----	4	16.7	-----	50.0	40'9"	8'5 $\frac{3}{4}$ "	-----	4'3 $\frac{9}{16}$ "
Tank car-----	2	14.0	(^b)	-----	21'2"	Not available	-----	5'
Tank car-----	4	26.4	(^c)	-----	33'1 $\frac{1}{2}$ "	Not available	-----	5'

^a Height of flatcar is determined by height of stanchion.

^b 4,356 US gallons.

^c 14,266 US gallons.

4-7. Dimensions, Weight, and Capacities of Predominant Types of Vietnam Freight Cars

Type of car	Number of axles	Light weight (ston)	Capacity		Inside dimensions (meters)			Door dimensions (meters)		Height of floor above top of rail (meters)
			Cubic meters	Pounds	Length	Width	Height	Width	Height	
Boxcar, G-----	2	6.0	22.95	22,045.8	5.414	2.120	2.0	1.45	1.9	1.0
Boxcar, GG-----	4	19.5	66.35	55,144.5	13.118	2.529	2.0	1.829	1.8	1.1
Flatcar, M-----	2	4.9	-----	22,045.8	-----	-----	-----	-----	-----	1.0
Flatcar, MM-----	4	13.0	-----	55,144.5	-----	-----	-----	-----	-----	1.0
Gondola, H-----	2	5.2	12.1	22,045.8	5.47	2.2	1.03	1.45	1.03	1.0
Gondola, HH-----	4	13.65	29.98	55,114.5	11.0	2.5	1.09	1.45	1.09	1.0
Gondola, USA-owned-----	4	16.5	26.88	60,000.0	10.6	2.39	-----	-----	-----	1.0
Tank car, MR-----	2	5.6	10.0	22,045.8	-----	-----	-----	-----	-----	1.0
Tank car, MMR-----	4	18.5	30.0	45,908.0	-----	-----	-----	-----	-----	1.08

4-8. Dimensions, Weight, and Capacities of Predominant Types of Korean Freight Cars

Type of car	Number of axles	Light weight (ston)	Capacity		Inside dimensions (meters)			Door dimensions (meters)		Height of floor above top of rail (meters)
			Cubic meters	Pounds	Length	Width	Height	Width	Height	
Boxcar-----	4	18.8	58.0	66,000	10.202	2.67	2.10	1.52	^a 1.8	Not available
Flatcar-----	4	17.0	-----	99,000	10.5	3.05	-----	-----	1.2	-----
Gondolas-----	4	12.7	46.64	66,000	10.084	2.643	1.75	-----	-----	Not available
Tank cars, Juna-----	4	20.5	(^b)	71,962	11.8	2.050	Not available	-----	-----	Not available
Refrigerator, mechanical, USA-owned.	4	29.5	-----	100,000	9.95	2.641	2.082	2.39	2.44	Not available

^a Estimates.

^b 9,620 US gallons.

4-9. Capacity of Standard US Passenger Cars

	<i>Day coach</i> ¹	<i>Tourist sleeper</i>	<i>Standard sleeper</i> ²
Length in feet -----	65-75	65-75	65-80
Number of sections -----	None	13-16	12-16
2 men to each double seat -----	60-70	52-64	53-64
3 men to each 2 double seats -----	45-52	39-48	40-48

Sleeping capacity:

	<i>Day coach</i> ¹	<i>Tourist sleeper</i>	<i>Standard sleeper</i> ²
2 men per berth (maximum) -----	None	52-64	53-64
3 men per section -----	None	39-48	36-48
1 man per berth -----	None	26-32	27-32

¹ Limited number of steel coaches, 70 feet long or over, available.

² Standard sleeper—12 sections and 1 drawing room or 16 sections and no drawing room.

Section III. OPERATIONS

4-10. Planning Requirements

In planning for the most effective use of a railway system, detailed information about items *a* through *z* is essential. FM 55-8 provides additional information on evaluating existing facilities.

- a.* Length of line.
- b.* Condition of roadbed and track.
- c.* Gage of track.
- d.* Single, double, or multiple track.
- e.* Weight of rail.
- f.* Type of ballast and depth.
- g.* Type of ties (if wood, treated or untreated).
- h.* Tie spacing.
- i.* Axle-load limitations (track and bridge).
- j.* Profile of line showing location and length of ruling grade.
- k.* Alinement of lines showing location and length of minimum-radius curves.
- l.* Location and description of bridges and tunnels.
- m.* Location and length of passing tracks.
- n.* Location, type, and quantity of fuel supply.
- o.* Location, quantity, and quality of water supply.
- p.* Location and capacity of yards.
- q.* Location and capacity of car repair shops and enginehouses.
- r.* Type and availability of motive power (weight in working order, expected working tractive effort, drawbar pull, and age).
- s.* Type and availability of rolling stock (capacity, dimensions, and age).

t. Climatic and prevailing weather conditions.

u. Diagrams showing minimum structure, maximum unrestricted loading, and equipment gages.

v. Signal system (wire or radio requirements and coordinating responsibilities).

w. Dispatching facilities.

x. Route junctions.

y. Availability of new equipment and repair parts.

z. Local labor resources.

4-11. Outline of Standing Operating Procedure for Rail Movements

a. General. Policies and factors involved in selecting and accomplishing movements via rail.

b. Supply Movements.

(1) *Releases.* When required, methods of obtaining, formats, dissemination, action required.

(2) *Routing.* Responsibilities and procedures for determination, coordination, and accomplishment.

(3) *Diversions and reconsignments.* Authority and initiating procedures for; method of execution.

(4) *Records and reports.* Responsibilities and methods for the maintenance of specific records; appropriate references to reports to be submitted.

c. Personnel Movements—Troops.

(1) *Military authorization identification numbers (MAIN).* Purposes, composition, methods, and procedures for assignment and use; marking on and eradicating from trains.

(2) *Halts.* Types; policies, procedures, and responsibilities for establishment and conduct.

(3) *Travel warrants.* Types, forms, authority, and responsibilities for issue, distribution, and usage.

(4) *Troop-train commanders.* Appointment, responsibilities, and functions; relationship with transportation personnel; instructions to be furnished (TM 55-204).

(5) *Rations and water.* Responsibilities and procedures for securing, furnishing en route, and disposition at destination.

(6) *Discipline of troops.* Responsibilities and command policies, police of rail equipment, sanitation.

(7) *Diversions.* Authority for ordering, responsibilities and procedures for effecting, reference to reporting.

(8) *Records and reports.* Responsibilities and methods for the maintenance of specific records and appropriate references to reports to be submitted.

4-12. Outline of Standing Operating Procedure for Transportation Railway Service

a. General. Policies and procedures for—

(1) Integration of rail transportation in the theater transportation net.

(2) Operational control.

(3) Coordination with adjacent commands for use of rail capacity and support of operating units.

(4) Coordination of the theater rail plan for selection, rehabilitation, and operation of rail lines in support of theater strategic plans.

b. Mission. Rail net and facilities operated; terminals, installations, and commands supported.

c. Organization. Operating units available, location, and operating limits.

d. Functions. Responsibilities for operation and maintenance of military railways, equipment, and freight, passenger, and special trains.

e. Planning.

(1) Long-range planning responsibility and procedures; selection of rail primary and alternate routes; determination of line capacity, troop equipment, and supply requirements; rehabilitation and project requirements; communications and security requirements; demolition plans.

(2) Current operational plans; current rail line capacity and requirements; phases of operation; selection and rehabilitation of new or additional railheads, yards, and installation facilities.

f. Operations. Procedures for dissemination and implementation of movement programs; coordina-

tion with transportation movements officer; priorities for and utilization of rail equipment; responsibilities for preparation and compilation of operational and situation reports; procedures for ordering and documentation of cars; responsibilities for scheduling special trains; construction and use of railcar spanners, responsibility and methods of loading, blocking, bracing, and inspecting loaded cars.

g. Maintenance. Responsibility, procedures, inspections, reports, and standards for maintenance of military and utility railway facilities and equipment, including organizational, field, and depot maintenance.

h. Supply. Responsibility and procedures for requisitioning, stocking, distributing, maintaining levels of, disposing of excess, and accounting for railway operating and maintenance supplies; requirements and priorities for major items, including locomotives and rolling stock.

i. Intelligence and Reconnaissance. Responsibility and procedures for collecting, processing, disseminating, and using intelligence.

j. Security. Procedures, responsibility, coordination, and requirements for security of supplies en route by rail and security of trains and rail line-of-communication facilities; defense and demolition plans.

k. Records and Reports. Responsibility and procedures for reports; railway operation, situation, personnel status, equipment maintenance and inspection, equipment status, and project.

l. Training. Responsibility for conducting unit and technical training.

4-13. Maximum Bulk Loading of Typical US Freight Cars

The rated weight capacity of a car does not mean that the car can carry the rated tonnage of all items. For many types of cargo, the cubic capacity of the car is reached ahead of the rated capacity. When this occurs, the tonnage that the car can carry represents its actual capacity.

a. High Density Items. Freight cars loaded with high density items can nearly always be loaded to their rated capacity. Examples of high density items are ammunition, barbed wire, cement, flour, gravel, corrugated iron, rails, rifles in chests, sand, stone, sugar, telephone wire, and engineer tools.

b. Lighter Bulk Items. Some items for which the cubic capacity of the car is reached at the time of or before the rated tonnage has been loaded are listed below.

Rated	<i>Car capacity in short tons</i>		
	30	40	50
Actual, by items:			
Blankets, baled	27	32	40
Bread	19	24	30
Canned goods in boxes	30	36	45
Clothing, baled	27	32	40
Meat	15	24	35
Motor vehicle parts	24	28	40
Sandbags	21	24	30
Tentage	15	20	30
Ties, railroad	19	26	32

4-14. Clearances—General

Overhead clearances and platform heights are measured from top of rail, side clearances from centerline of track. Clearances below those specified are dangerous, and protection must be provided by appropriate warning signs or devices. For example, telltales must be used for overhead clearances ranging between 18 to 22 feet. Unless local conditions require greater clearances, the

standard minimum clearances are as follows:

a. Overhead.

	<i>Feet and inches</i>	
	<i>Meters</i>	<i>inches</i>
Wires:		
High voltage	8.53	28' 0"
Other	8.23	27' 0"
Structures	6.71	22' 0"

b. Side.

Buildings	2.59	8' 6"
Canopies:		
Up to 15' 6"	2.59	8' 6"
Higher than 15' 6"	1.68	5' 6"

Platforms:

3' 9"	1.88	6' 2"
4'	1.52	5' 0"

Refrigerator platforms:

3' 2"	1.88	6' 2"
4' 7"	2.59	8' 6"

c. Enginehouse Entrance.

Overhead	5.18	17' 0"
Side	1.98	6' 6"

d. Bridge and Tunnel. Standard single-track bridge and tunnel clearances are shown in figure 4-2.

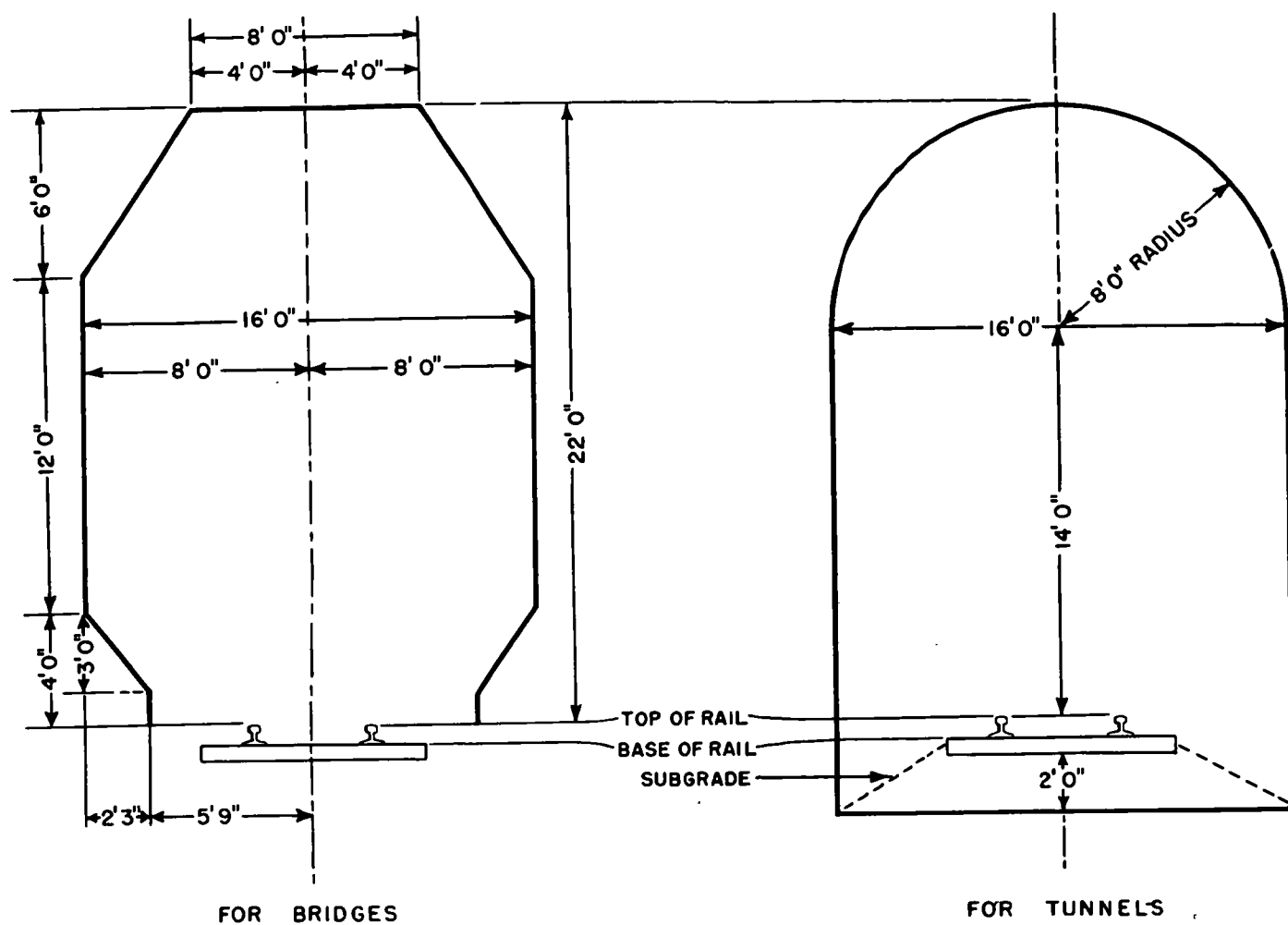


Figure 4-2. Standard single-track bridge and tunnel clearances.

4-15. Railway Gages (in inches) by Area

Gages	23%	24	29½	30	35	36	37	37½	37¾	39%	40	41¼	41½	41¾	42	58½	58¾	60	63	66
<i>a. Africa.</i>																				
Algeria.....	—	—	—	—	—	—	—	—	—	X	—	—	—	X	—	X	—	—	—	—
Cameroun.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Central African Republic.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Chad.....	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—
Congo, Republic of (Brazzaville).....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	X	—	—	—	—	—
Congo, Republic of (Kinshasha).....	X	X	—	—	—	—	—	—	—	X	—	—	—	—	X	—	—	—	—	—
Dahomey.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Egypt (UAR).....	—	—	X	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—
Ethiopia.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Gabon.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	X	—	—	—	—	—
Ghana.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Guinea.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—
Ivory Coast.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Kenya.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Liberia.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Libya.....	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Malagasy (Madagascar).....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Mali.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Mauritania.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Morocco.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Niger.....	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	X	—	—	—	—
Nigeria.....	—	—	—	X	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Nyasaland (Malawi).....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Portuguese East Africa (Mozambique).....	—	—	X	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Portuguese West Africa (Angola).....	X	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Republic of South Africa.....	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Reunion (Republic of France).....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Rhodesia.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—

Senegal.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Sierra Leone.....	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Somalia.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Sudan.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Swaziland.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Tanzania.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Togo.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Tunisia.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X	-
Uganda.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Upper Volta.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	^	^
Zambia.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
<i>b. Asia.</i>																			
Afghanistan.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-
Bangladesh.....	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X
Borneo.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Burma.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Cambodia.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Ceylon.....	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
China.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Formosa.....	-	X	-	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
India.....	-	X	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X
Indonesia.....	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Iran.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Iraq.....	-	-	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-	X	-
Israel.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Japan.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X
Jordan.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Korea.....	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Laos.....	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Lebanon.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Malaya.....	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-

Gages	23 5/8	24	29 1/2	30	35	36	37	37 5/8	37 1/2	39 5/8	40	41 1/4	41 1/2	41 3/8	42	56 1/2	56 3/4	60	63	66
Nepal.....	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	X
Pakistan.....	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	X
Saudi Arabia.....	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	X	—	—	—	—
Syria.....	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	X	—	—	—	—
Thailand.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Tibet.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Turkey.....	—	—	X	—	—	—	—	—	—	X	—	—	X	—	—	X	—	—	X	—
U.S.S.R.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X	—
Vietnam.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
<i>c. Europe.</i>																				
Albania.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Austria.....	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—
Belgium.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—
Bulgaria.....	X	—	X	X	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Czechoslovakia.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	X	—	—
Denmark.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Estonia (U.S.S.R.).....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—
Finland.....	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—
France.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—
Germany.....	X	—	X	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—
Greece.....	—	—	X	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—
Hungary.....	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	X	—	X	—	—
Ireland, Republic of.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X
Italy.....	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	X	—	—	—	—
Latvia (U.S.S.R.).....	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	X	—
Lithuania (U.S.S.R.).....	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	X	—
Luxembourg.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Netherlands.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Norway.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	X	X	—	—	—	—
Poland.....	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	X	—

Portugal.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X
Rumania.....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X	—	—	—	X
Spain.....	X	—	—	—	—	X	—	—	—	X	—	—	—	—	—	—	—	—	X
Sweden.....	—	—	—	—	X	—	—	—	—	—	—	—	—	X	X	—	—	—	—
Switzerland.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	X	—	—	—	—
Turkey.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
U.S.S.R.....	X	—	—	—	—	—	—	—	—	X	—	—	—	X	X	—	—	—	X
United Kingdom.....	X	X	—	X	—	—	—	—	—	—	—	—	—	X	X	—	—	—	—
Yugoslavia.....	X	—	—	X	—	—	—	—	—	X	—	—	—	—	X	—	—	—	—

d. Central America and West Indies.

Costa Rica.....	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Cuba.....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X	—	—	—	—
Dominican Republic.....	—	—	—	X	—	—	—	—	—	—	—	—	—	X	—	X	—	—	—
El Salvador.....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Guatemala.....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Haiti.....	—	—	—	X	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Honduras.....	—	—	—	—	—	X	—	—	—	—	—	—	—	X	—	—	—	—	—
Jamaica.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Nicaragua.....	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Panama.....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X
Puerto Rico.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—
Trinidad.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—

e. North America.

Canada.....	—	—	—	—	—	X	—	—	—	—	—	—	—	X	X	—	—	—	—
Newfoundland.....	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Mexico.....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	X	—	—	—	—
United States (CONUS).....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Alaska.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Hawaii (see Pacific Ocean).....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—

Gages	23½	24	29½	30	35	36	37	37½	37½	39½	40	41¼	41½	41½	42	56½	56½	60	63	66
<i>f. South America.</i>																				
Argentina.....	—	—	X	—	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	X
Bolivia.....	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Brazil.....	—	—	—	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	X
British Guiana.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Chile.....	X	—	—	X	—	—	—	—	—	X	—	—	—	—	X	X	—	—	—	X
Colombia.....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ecuador.....	—	—	—	X	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Paraguay.....	—	X	X	X	—	—	—	—	—	X	—	—	—	—	—	X	—	—	—	—
Peru.....	X	—	—	—	—	X	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Surinam (Dutch Guiana).....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
Uruguay.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Venezuela.....	—	X	—	X	—	—	—	—	—	X	—	—	—	—	X	X	—	—	—	—
<i>g. Pacific Ocean.</i>																				
Australia.....	—	—	—	X	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—	X
Hawaii.....	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—
New Caledonia.....	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—
New Zealand.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Philippines.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—
Tasmania.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—	—

4-16. Clearances and Gages

The sample clearance diagrams shown in figures 4-3 and 4-4 refer to the distance that equipment or cargo may project to the side at various heights above track level. They are composites incorporating the smallest dimensions of all similar dimensions of the countries having the gages shown (para 4-5); therefore, not all the limiting clearances shown in the composites will exist simultaneously on any particular rail line. A clearance diagram for the rail line(s) over which operations are to be conducted must be obtained or made. Horizontal distances shown in the diagrams

should not be confused with the track gage. The composite clearances in figure 4-3 show minimum clearances for the standard-gage (56½-inch), and for the broad-gage track indicated. Figure 4-4 shows clearances for three sizes of narrow-gage track. Examples of the use of the diagrams are given below.

a. In figure 4-3, a vertical clearance of 3 feet 8 inches can be depended upon for a width clearance which is at least 9 feet 8 inches. In the same figure, a vertical clearance of $9\frac{3}{4}$ inches can be depended upon if the width clearance is not less than 8 feet $11\frac{1}{2}$ inches.

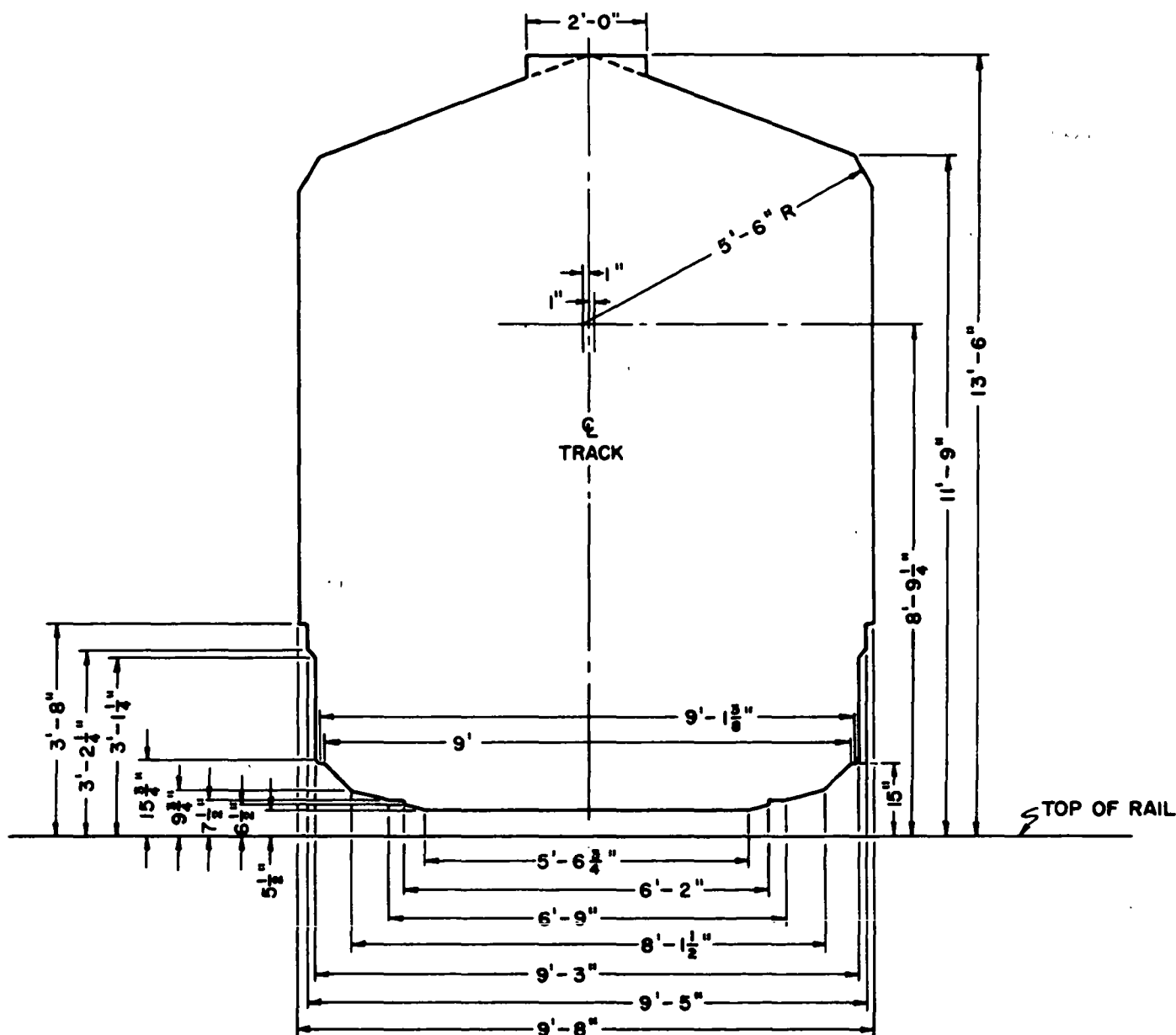
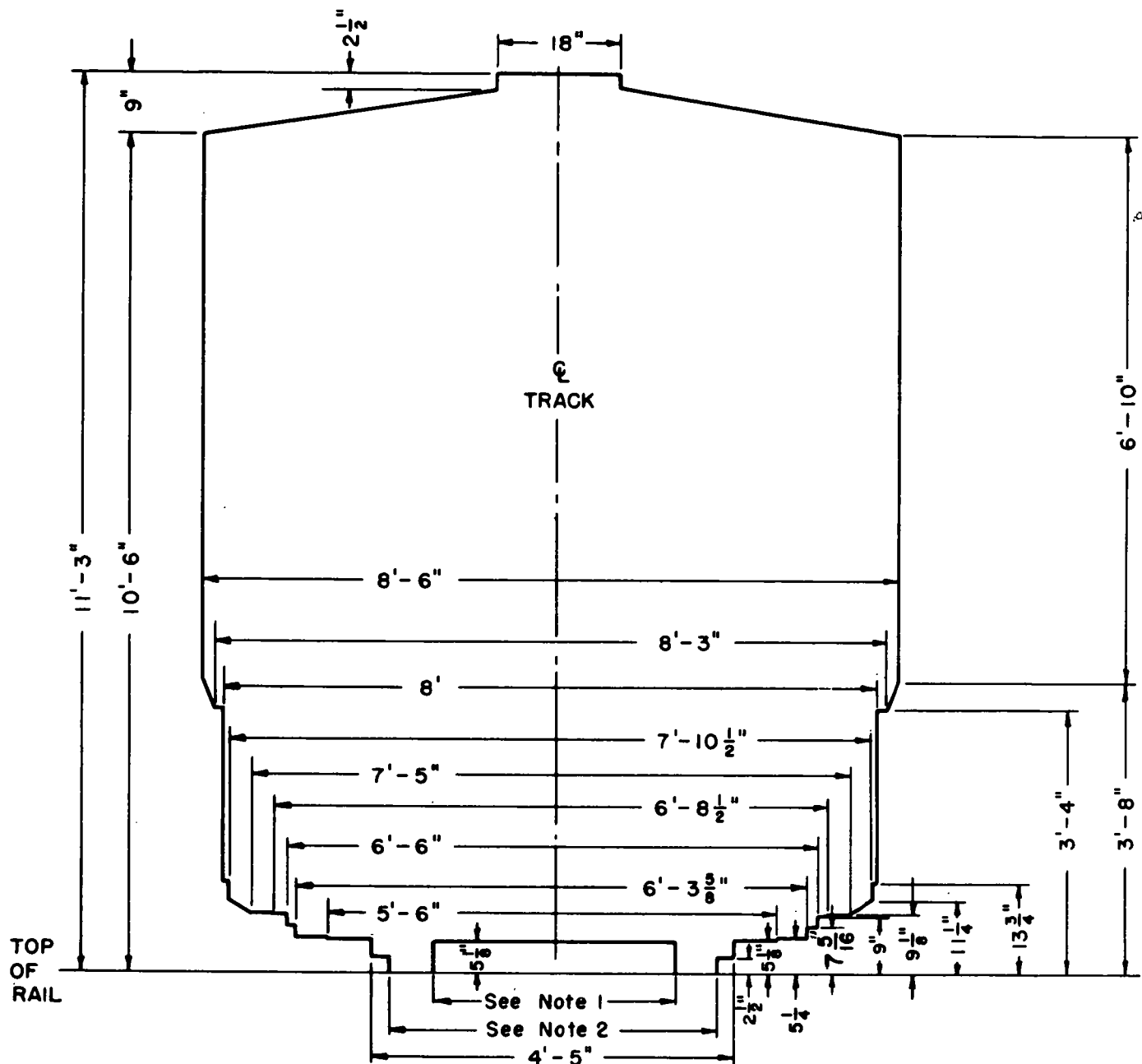


Figure 4-3. A composite clearance diagram: 56½-, 60-, 63-, and 66-inch gages.



Note 1: 2'-8 $\frac{3}{4}$ " for 36-inch track gage
3' for 39 $\frac{3}{8}$ - and 42-inch track gage

Note 2: 4' for 36- and 39 $\frac{3}{8}$ -inch track gage
4'-5" for 42-inch track gage

Figure 4-4. A composite clearance diagram: 36-, 39 $\frac{3}{8}$ -, and 42-inch gages.

b. In figure 4-4, a vertical clearance between 13 $\frac{3}{4}$ inches and 3 feet 4 inches can be depended upon when the width clearance is not less than 8 feet.

4-17. Bridge Capacity

a. *Cooper's E Rating.* This figure indicates, in thousands of pounds, the weight a bridge can support for each driving axle of a locomotive. Mil-

tary railroad bridges are normally designed for Cooper's E-45 but may be built for lighter or heavier loadings as required. For example, the following method is used to determine the rating a bridge must have if it is to be crossed safely by a 2-8-0 (steam) locomotive weighing 140,000 pounds on drivers:

A 2-8-0 locomotive has four driving axles.

140,000 pounds (weight of locomotive) divided by 4 (number of driving axles) equals 35,000 pounds (weight per driving axle).

Therefore, any bridge which has a rating of E-35 or above can be crossed safely by this locomotive.

b. *Steel I-Beam Bridge (Fig. 4-5).* The chart below refers to bridges already constructed with two, four, six or more steel stringers or girders of equal dimensions. To estimate the capacity of a railway bridge with this type of construction, the

width and thickness of the lower flange of one stringer are measured at the center of the span length; the depth and length of the stringer are also measured. Using the chart below, the steel stringer that is nearest to these dimensions is selected, and the corresponding E-rating of the bridge is read. The rating is reduced according to the age and condition of the bridge. The quantity of reduction must be determined by qualified personnel, normally from the Corps of Engineers. For additional information concerning bridge capacities, refer to TM 5-312.

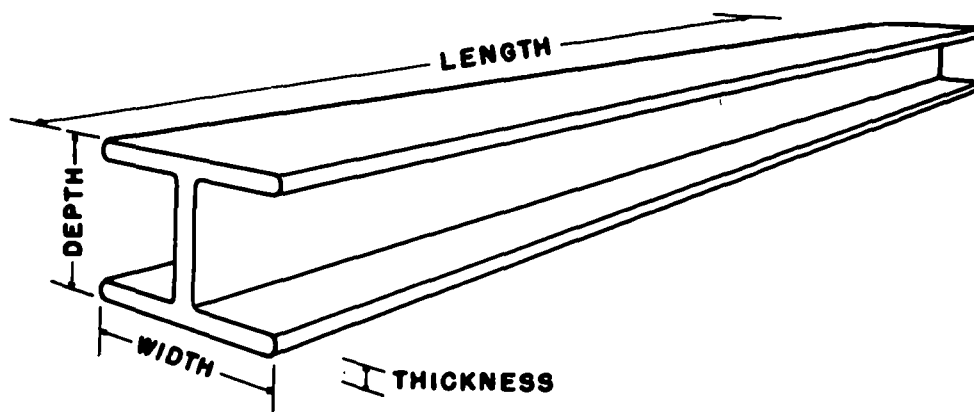


Figure 4-5. Measuring a steel stringer.

Lower flange

[illegible]

(This chart presents data for determination of order of magnitude of stringers. One stringer per rail is assumed. Qualified personnel from Corps of Engineers should be consulted for bridge capacity.)

Stringer dimensions (in.)

Lower flange

Thickness	Width	Stringer depth	Span length (ft.)																
			22	24	26	28	30	35	40	44	50	54	60	64	70	74	80	84	90
1/2	10 3/8	30	E-27																
1/2	12 1/2	30	E-31	E-26															
1	14	36	E-51	E-48	E-43	E-39	E-34	E-26											
1/2	12 3/8	42	E-45	E-39	E-34	E-30	E-26												
1 1/8	14	42	E-60	E-57	E-54	E-51	E-45												
1 1/8	16	42				E-60	E-54	E-42	E-32										
1 1/2	16	48					E-59	E-52	E-47	E-43	E-33								
1	16	48					E-66	E-57	E-45	E-35	E-30								
1 5/8	14	54						E-54	E-43	E-36	E-28								
1 3/4	14	60							E-60	E-54	E-43	E-37	E-30	E-27					
1 1/2	14	60							E-57	E-48	E-38	E-33	E-27						
2 1/8	15	66									E-57	E-54	E-46	E-41	E-34	E-31	E-26		
2	14	66										E-56	E-48	E-40	E-35	E-30	E-26		
2	14	72										E-62	E-54	E-44	E-39	E-32	E-29	E-25	
2 1/2	15 1/2	72											E-55	E-51	E-43	E-38	E-33	E-29	
2 1/8	14	78										E-64	E-52	E-46	E-39	E-35	E-30		
2 1/2	16	84												E-64	E-54	E-49	E-41	E-38	E-30
2 11/16	20	96																E-59	E-51

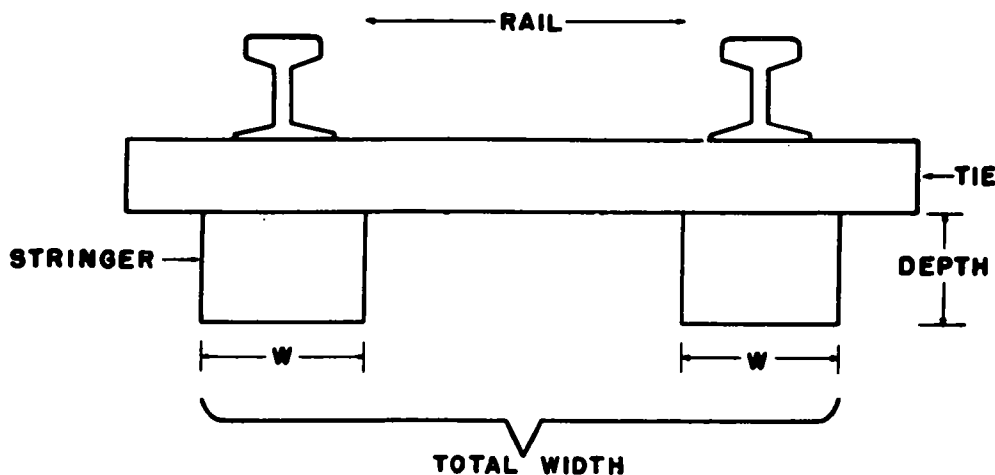


Figure 4-6. Measuring a wooden stringer.

c. *Wooden Bridge* (Fig 4-6). For a bridge with wooden stringers, the width of each stringer is measured under one track at the center of the longest span and added to obtain total stringer width. In figure 4-6, the total stringer width is 2 x W. The depth and length of one stringer are also measured. The following table is used with the same procedures as the table in b above.

Stringer dimensions
(in.)

Width	Depth										
10	12	14	16	18	20	22	24	26	28	30	32
18	12	E-16	E-12								
18	14	E-22	E-18	E-10							
18	16	E-28	E-20	E-15	E-10						
18	18	E-38	E-26	E-18	E-14	E-12					
20	12	E-18	E-12								
20	14	E-25	E-17	E-12							
20	16	E-33	E-23	E-16	E-12	E-10					
20	18	E-43	E-29	E-21	E-16	E-13	E-10				
24	12	E-22	E-15	E-11							
24	14	E-30	E-21	E-14	E-11						
24	16	E-40	E-28	E-20	E-15	E-12					
24	18	E-52	E-36	E-25	E-19	E-15	E-12	E-10			
36	12	E-34	E-23	E-17	E-12	E-10					
36	14	E-47	E-32	E-23	E-17	E-14	E-11				
36	16	E-62	E-43	E-30	E-23	E-19	E-15				
36	18	E-78	E-53	E-30	E-30	E-24	E-20	E-16			
40	12	E-38	E-26	E-19	E-14	E-11					
40	14	E-52	E-36	E-26	E-20	E-16	E-12				
40	16	E-69	E-47	E-35	E-26	E-21	E-17	E-17			
40	18	E-87	E-60	E-44	E-34	E-27	E-22	E-18			
48	12	E-46	E-31	E-23	E-17	E-13					
48	14	E-63	E-43	E-31	E-24	E-19	E-15				
48	16	E-83	E-57	E-41	E-32	E-26	E-21				
48	18	E-105	E-73	E-53	E-41	E-33	E-27	E-22			
54	12	E-52	E-35	E-27	E-19	E-15					
54	14	E-72	E-49	E-35	E-22	E-18					
54	16	E-94	E-65	E-46	E-36	E-29	E-24				
54	18	E-119	E-82	E-60	E-46	E-38	E-30	E-25			
60	12	E-58	E-40	E-30	E-22	E-17					
60	14	E-79	E-55	E-39	E-30	E-35	E-20				
60	16	E-104	E-72	E-52	E-40	E-33	E-27				
60	18	E-132	E-92	E-67	E-52	E-42	E-34	E-28			

4-18. Loading Open-Top Cars

Military equipment loaded on Department of Defense-owned cars traveling over the lines of common carriers and on cars belonging to common carriers within the continental United States must meet the loading standards of the individual railroad and those of the Association of American Railroads (AAR). Cars loaded on railroads of foreign countries must meet the blocking and lashing standards of the country involved. Standardization Agreements (STANAG) govern the loading of military equipment on rail lines of the NATO nations in Europe. The standards for and methods of blocking, nailing, and bracing for some typical military loadings are given in this paragraph. Association of American Railroads' regulations, *Rules Governing the Loading of Department of Defense Material on Open-Top Cars*, on file at all ITO in CONUS (see also para 4-20) should be followed. The following examples apply only to the loading of flatcars and composite gondolas with wooden floors with the equipment listed in a through d below and illustrated in figures 4-7 through 4-11. The letters in the item column refer to the letters shown in the illustrations. In all examples, brake wheels have the clearances shown in figure 4-12. The various wooden blocks, cut to specific patterns and numbered, are illustrated in figure 4-13. Additional details are contained in TM 55-601.

A. Six-Wheel truck (Fig 4-7).

Item	No. of pieces	Description
A		Brake-wheel clearance. See figure 4-12.
B	8 or 12 as required	Block, pattern 16. Locate 45° portion of block against front and rear of front wheels, in front of inside and outside in-

Item	No. of pieces	Description	Item	No. of pieces	Description
		intermediate wheels and in back of inside and outside rear wheels. Nail heel of the block to the car floor with three 40d nails and toenail that portion of the block under the tire to the car floor with two 40d nails before items C and D are applied.			stake-pockets on the same side of the car. When load exceeds 22,000 pounds, 8 strands of No. 8-gage wire is used. Metal fillers sufficient to provide a suitable radius must be used to protect the wire at stake-pockets and applied so as to prevent dislodgement. Twist wires taut with a rod, bolt, or suitable length of 2- by 2-inch lumber and secure to prevent unwinding (sketch 2, fig. 4-7). Substitute, if desired, ½-inch IWRC steel cable in a complete loop and secure with four ½-inch cable clips. Thimble must be used at the stake-pocket (sketch 3, fig. 4-7), to protect the cable and be secured to the cable with one cable clip.
C	1 each item D	Suitable protective material, such as waterproof paper or burlap, etc. Locate bottom portion under item D, the top portion to extend 2 inches above item D.			
D	4 or 6 as required	Each to consist of one piece of 2- by 6- by 36-inch lumber and three pieces of 2- by 4- by 36-inch lumber. Nail one edge of the 2- by 6- by 36-inch piece with five 12d nails. Then place against the tire and nail to the car floor through the 2- by 4-inch piece with four 20d nails. Nail the other two pieces of 2- by 4- by 36-inch to the one below in the same manner (sketch 1, fig. 4-7).	F	8 or 12 as required	Each to consist of six strands of No. 8-gage black-annealed wire. Pass through the spokes or holes in the front and rear wheels and through the car stake-pockets so that they form an X across the face of the wheel. Twist taut with a rod, bolt, or suitable length
E	4 each unit	Six strands of No. 8-gage wire. Attach to the shackles located at each end of the unit and to			

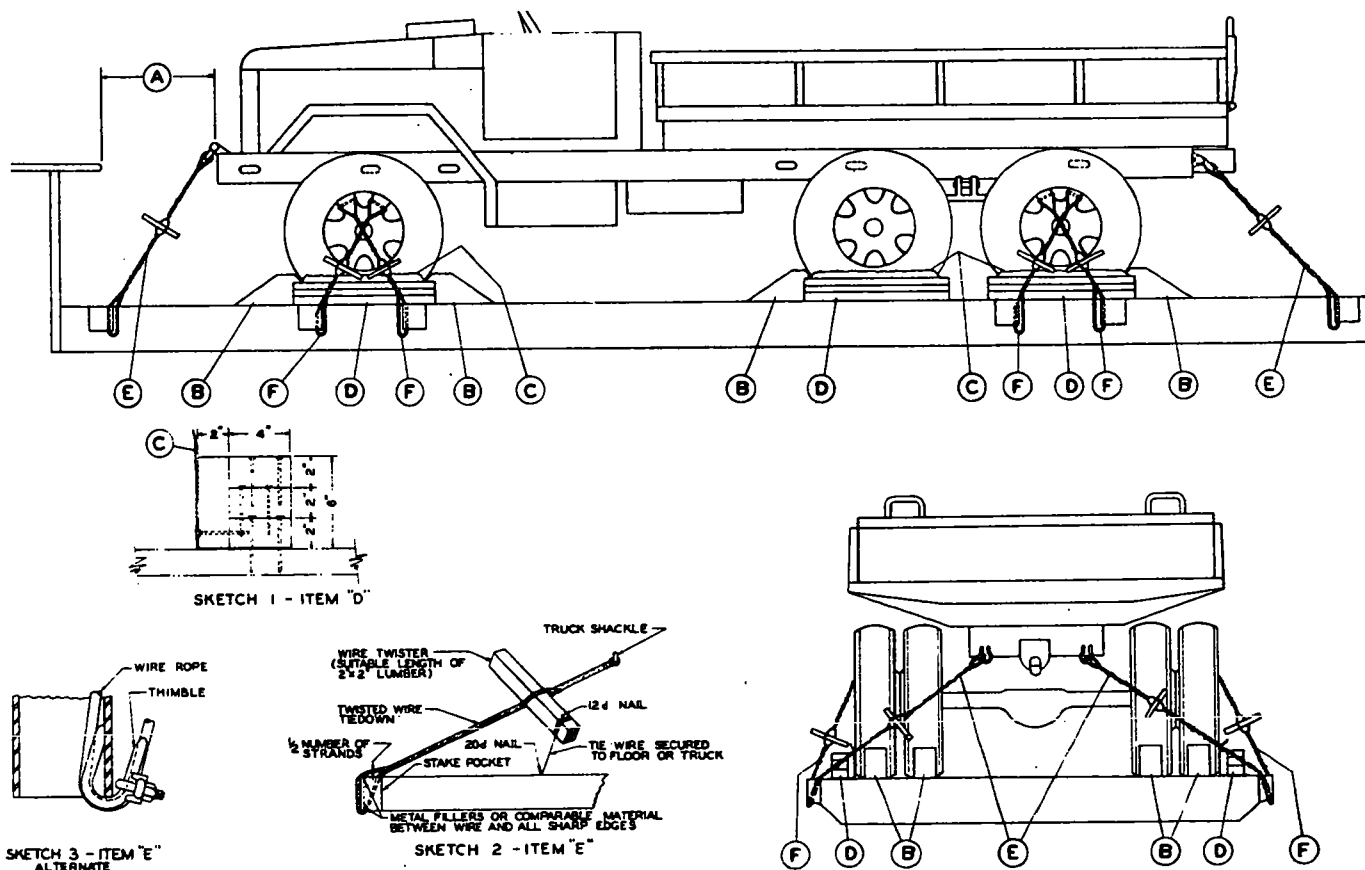


Figure 4-7. Loading a six-wheel truck on an open-top car.

- | Item | No. of pieces | Description |
|------|---------------|--|
| | | of 2- by 2-inch lumber and secure to prevent unwinding. When load exceeds 22,000 lb., use additional F applied to the intermediate rear wheels. |
| 1. | | All handbrakes are to be set with the hand levers wired or blocked. Gear shift levers for automatic or conventional transmissions must be placed and wire-tied in neutral position. Clutch pedal is to be secured in depressed position by wiring to floor board plate or by wiring a wood block to the pedal shaft beneath the floor board. |
| 2. | | When No. 8-gage wire is used for tiedown purposes, the wire is to be threaded in a continuous length until all the required number of strands are formed (one complete loop consists of two strands). |
| 3. | | Tires are to be inflated to 10 psi above highway operating pressures. |

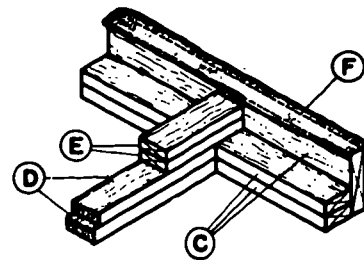
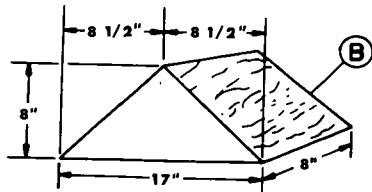
b. Lighter, Amphibious, 5-Ton (LARC-V) (Fig 4-8).

Item	No. of pieces	Description
A	-----	Brake-wheel clearance (fig 4-12).
B	16	Blocks, pattern 15 (fig 4-13). Locate two in front and two in rear of each of the four wheels, and secure to floor with two 60d nails in the heel of block and two 40d nails in each side of block.
C	4	Rub-rail assemblies, see sketch A (fig 4-8). Nail 2- by 8- by 36-inch vertical member to the lower piece of 2- by 4- by 36-inch lumber with five 12d nails. Position this assembly with 2- by 8-inch lumber against tire and secure to floor of car through 2- by 4-inch piece with five 20d nails. Secure second 2- by 4- by 36-inch piece of lumber to the lower 2- by 4-inch piece with five 20d nails.
D	2	Each to consist of two pieces of 2- by 4-inch lumber, length equal to distance between items C. Secure lower piece to floor with 20d nails spaced 8 inches apart. Nail top piece to lower piece in like manner.
E	4	Two pieces of 2- by 4- by 24-inch lumber. Nail to items C and D, using eight 20d nails to each piece.
F	4	Suitable protective material between tires and rub-rail assemblies. 5/8-inch diameter ca-

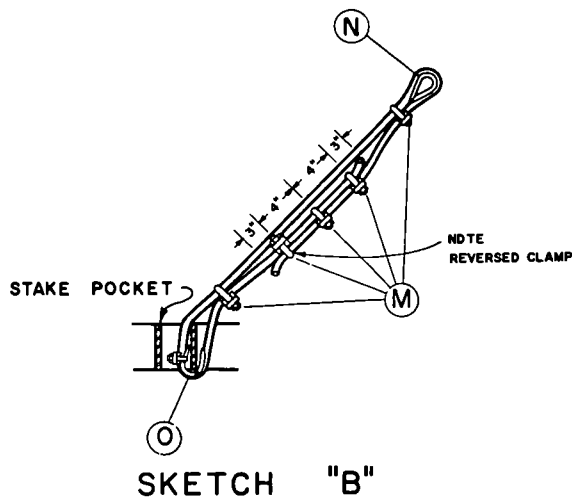
Item	No. of pieces	Description
G	6	ble, 6 by 19 IWRC. Form complete loop with 14-inch overlap. See sketch B.
H	4	Same as item G, except with 26-inch overlap. See sketch C (fig 4-8) for fittings.
J	3	Shackles. For vehicles having a 11/16-inch hole in the towing bracket, use a 1-inch diameter pin with a 7/8-inch steel galvanized coated anchor shackle. For vehicles having a larger hole in the towing bracket use an appropriate size pin and shackle. Attach the shackle to the towing bracket and secure the pin with a cotter key.
K	4	2- by 4- by 14 1/2-inch wood protective spacer between cable and side of vehicle. Secure to cable with staples.
L	4	Rubber hose protective spacer, 15 inches long. See sketch C.
M	64	5/8-inch cable clamp, U-type only.
N	6	5/8-inch closed thimble at load end of bow and stern cables.
O	10	5/8-inch open thimble.

c. Mounted Gun or Howitzer (fig 4-9). 1,2

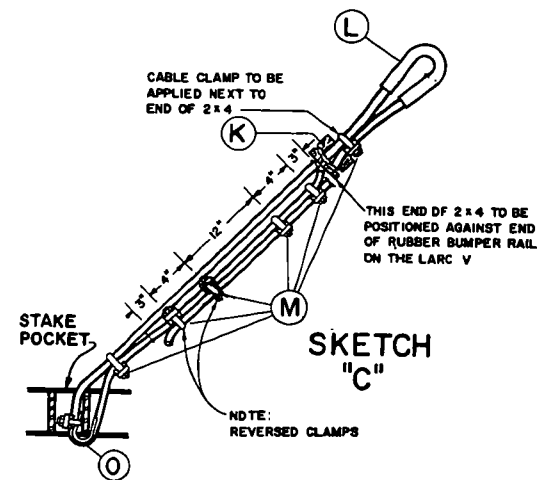
Item	No. of pieces	Description
A	-----	Brake-wheel clearance (fig 4-12).
B	4	Blocks, pattern 16 (fig 4-13). Locate 45° portion of block at front and rear wheels. Secure heel of block to floor with three 40d nails and toenail that portion under tire to floor with two 40d nails before items C are applied.
C	2	Each consisting of two pieces of lumber 2- by 4- by 36-inches. Secure lower piece to floor with three 40d nails and top piece to one below in like manner.
D	2	Support, pattern 62 (fig 4-18), length 1/4-inch longer than the distance between point of support on gun carriage to partially relieve weight on tires. Secure each to floor with six 40d nails.
E	2	Four strands of No. 8-gage, black annealed wire. Pass through holes in wheels and secure to stake-pockets.
F	2 for single spade, 4 for double spade	6- by 8- by 24-inches, cut to fit contour of spade. Locate in front and rear of spade. Toenail to floor with five 40d nails.



SKETCH "A"

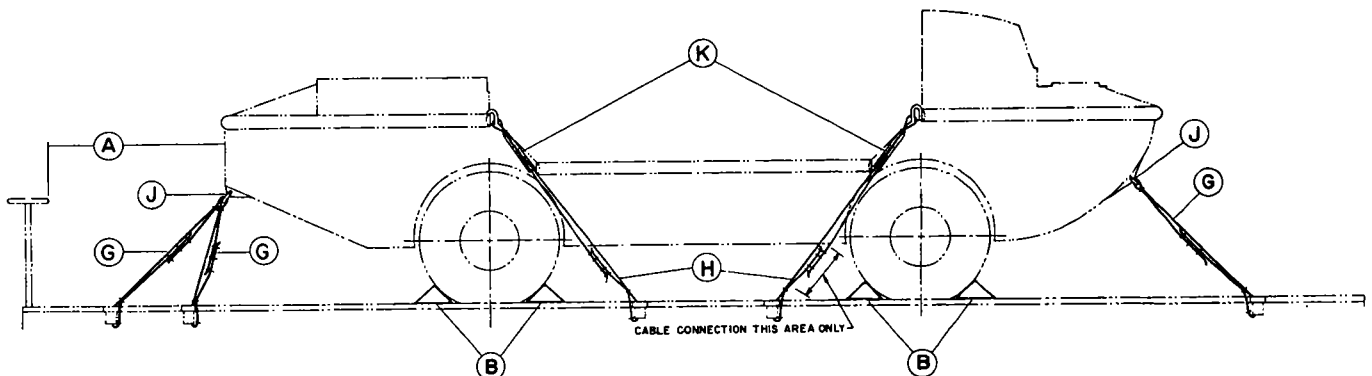


SKETCH "B"



SKETCH "C"

Figure 4-8. Blocking and tiedown details.



TIE DOWN SEQUENCE — SIDE CABLES "H" TO BE APPLIED AFTER ALL OTHER CABLES HAVE BEEN TIGHTENED. THE PROPER DEGREE OF TIGHTNESS FOR CABLE "H" IS OBTAINED BY POSITIONING SPACER "K" AS SHOWN IN SKETCH C AND TIGHTENING CABLE UNTIL FIRM CONTACT IS MADE THROUGHOUT THE LENGTH OF SPACER. APPLY SPACER STAPLES AFTER CABLE PULLER IS REMOVED.

Blocking and tiedown details, side view
Figure 4-8—Continued.

Item	No. of pieces	Description
G	2 each item F	Each consisting of two pieces of lumber 2 by 4 by 12 inches. Secure lower piece to floor, against item F, with three 40d nails and top piece to one below in like manner.
H	2	2 by 4 by 12 inches. Locate against each side of spade and secure to floor with three 40d nails.
J	1 pair	Stakes or green saplings. Locate one-third of distance from end of gun trail to center of wheels.
K	1	Six strands, No. 8-gage, black annealed wire. Loop around and over top of rear end of gun trail and secure to opposite stake-pockets. Substitute, if desired, 2- by .05-inch high-tension bands or ½-inch steel cables.

d. Tanks and Similar Units, From 60,000 to 100,000 Pounds (Fig 4-10).^{1,2,3,4}

Item	No. of pieces	Description
A	-----	Brake-wheel clearance (fig 4-12).
B	2	Blocks, pattern 31 (fig 4-13). Locate one against each rear crawler tread.
C	2	Blocks, pattern 30 (fig 4-13). Locate one against each front crawler tread.
D	2 each items B and C	2 by 4 by 20 inches. Locate one on inside of items B and C and secure to floor with six 20d nails.
E	2 each items B and C	Each consisting of two pieces of lumber 2 by 4 by 12 inches. Locate against ends of items B and C. Secure lower piece to floor with four 20d nails and top piece to one below in like manner.
F	2 each unit	Each consisting of 2 pieces of lumber 2 in. by 4 in. by 14 feet. Locate on floor against inside of each crawler tread,

^{1, 2} See notes at end of *d* below.

Hand brakes must be set and levers wired or blocked.
See General Rules for further details.

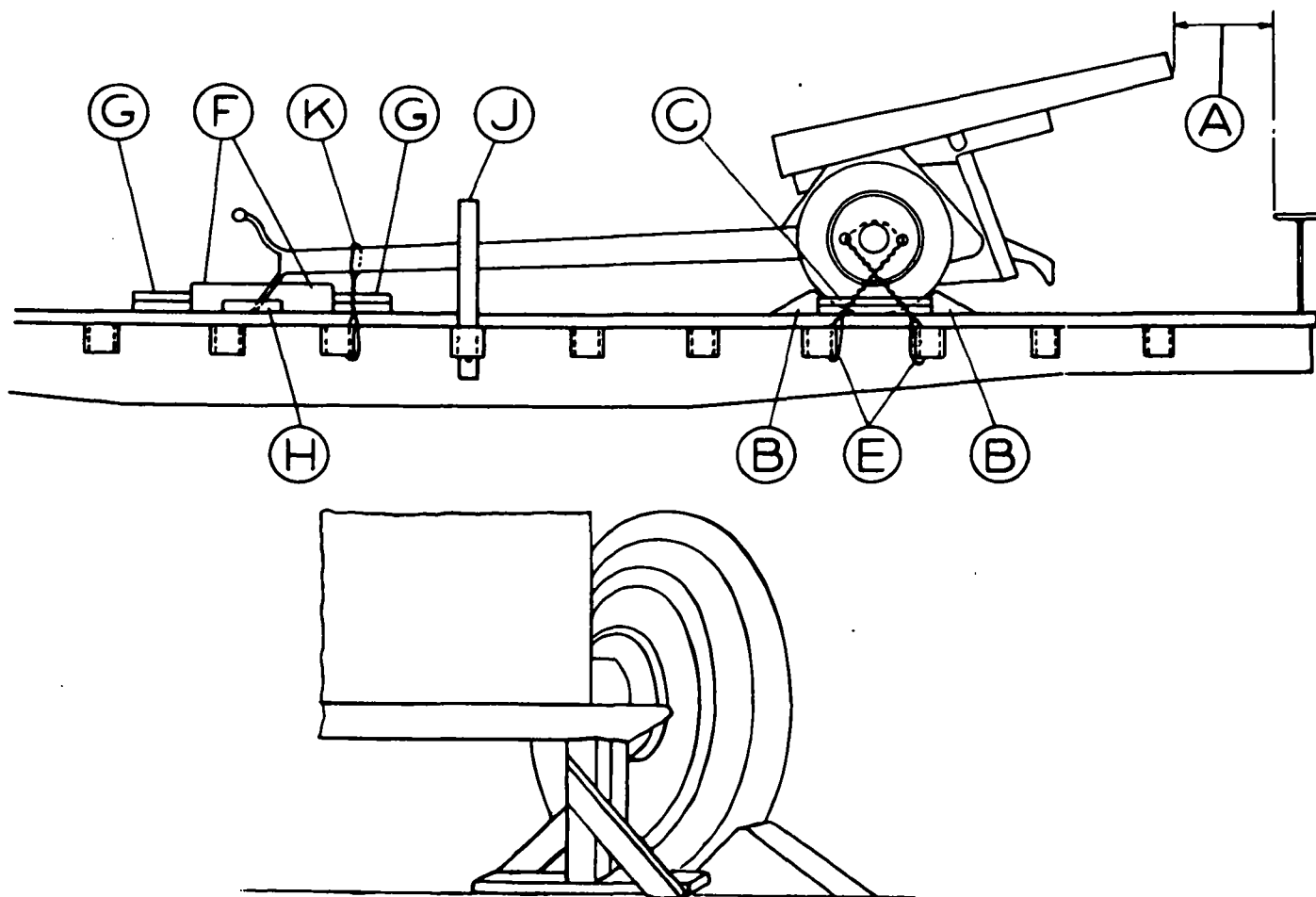


Figure 4-9. Loading a 37mm to 105mm mounted gun or howitzer on an open-top car.

Item	No. of pieces	Description
		and secure lower piece to floor with twelve 30d nails and top piece to one below in like manner.
G	3 each unit	Each consisting of two pieces of lumber 2 by 4 inches, long enough to fill space between item F. Locate one near center and one near each end of items F. Secure lower piece to floor with four 30d nails and top piece to one below in like manner.
H	6	Each consisting of two pieces of lumber 6 by 6 inches, length to suit, cut to fit contour of bogie wheels. Locate one piece between inside and outside wheels of each bogie assembly.
J	6	Each consisting to two pieces of lumber 4 by 4 inches, length to suit. Locate against bogie wheels on top of item H.
K	6	Each consisting of two pieces of lumber 4 by 4 inches, long enough to fill space between items H with two 20d nails.
L	12	Each consisting of two strands No. 8-gage, black annealed wire. Pass under crawler tread and around items H and J. Substitute, if desired, at each location, one $\frac{3}{4}$ - by .035-inch high-tension band. Use staples or nails bent over to retain bands or wires in position.
M	4	1 $\frac{1}{4}$ -inch-diameted rods. Attach to lifting lugs and pass through stake-pockets and $\frac{1}{2}$ - by 4- by 10-inch plates underneath stake-pockets on opposite sides of car. Substitute, if desired, $\frac{3}{8}$ inch steel cable, doubled.
N	2 each unit	$\frac{3}{8}$ -inch steel cable, 6 x 19 IWRC. Apply two $\frac{3}{8}$ -inch cables in a complete loop securing gun barrel to unit at each side. Not required when unit is equipped with external built-in gun brace; however, if external gun brace is in-operative, cable may be used. Substitution of wire or banding is not authorized.

When necessary to extend floor to provide bearing for wheels or for the application of items D on units loaded on floor of car, apply one piece of blacking on top of stake-pockets, long enough to extend beyond wheel chock blocks and high

enough to be level with top of floor. Use 1- by 4- by 18-inch lumber at each end of blocking, nail each to floor with three 20d nails and to blocking with two 20d nails. This method is illustrated in figure 1-C, section I, AAR Loading Rules. Figure 4-10, when applicable, may be used for the loading of vehicles being shipped under the provisions of DOT Special Permit No. 3498 during a *National Emergency* providing the gross weight per vehicle does not exceed 100,000 pounds each, use figure 4-11.

¹ When tiedown rods are found slightly loose while in transit, they need not be tightened.

² Place turret gun in straight forward position, and wire turret-lock handwheel and elevating-mechanism handwheel to prevent rotating.

³ Handbrakes must not be set.

⁴ For loads superimposed above car floor, use method illustrated in figure 4-11.

e. Tanks and Similar Units, 100,000 Pounds and Over (Fig 4-11).^{1,2,3,4}

Item	No. of pieces	Description
A	-----	Brake-wheel clearance (fig 4-12).
B	2	10 inches by 18 inches by 24 feet. Locate, as shown along each side of car. Secure each to car with at least five bolts 1 inch in diameter passed through items B and C, wood filler in stake-pocket, and $\frac{1}{2}$ - by 4- by 10-inch plate underneath stake-pocket. Not required for units loaded on floor of car.
C	As required	Metal filler, length, width, and thickness to suit. Locate between items B and top of stake-pockets. Not required when units are loaded on floor of car.
D	4	Each to consist of two pieces of lumber 2 by 6 by 18 inches. Locate against item B, as shown. Secure lower piece to floor with four 30d nails and top piece to one below in like manner. Not required for units loaded on floor of car.
E	2	Blocks, pattern 30. Locate one against each front crawler tread.
F	2	Blocks, pattern 31. Locate one against each rear crawler tread.
G	2 each items E and F	2 by 3 by 20 inches. Locate as shown against each side of items E and F and secure to floor or item B with four 20d nails in each.
H	4	Each to consist of two nieces of lumber 2 by 12 by 18 inches. Locate one against each item E and F. Secure lower piece

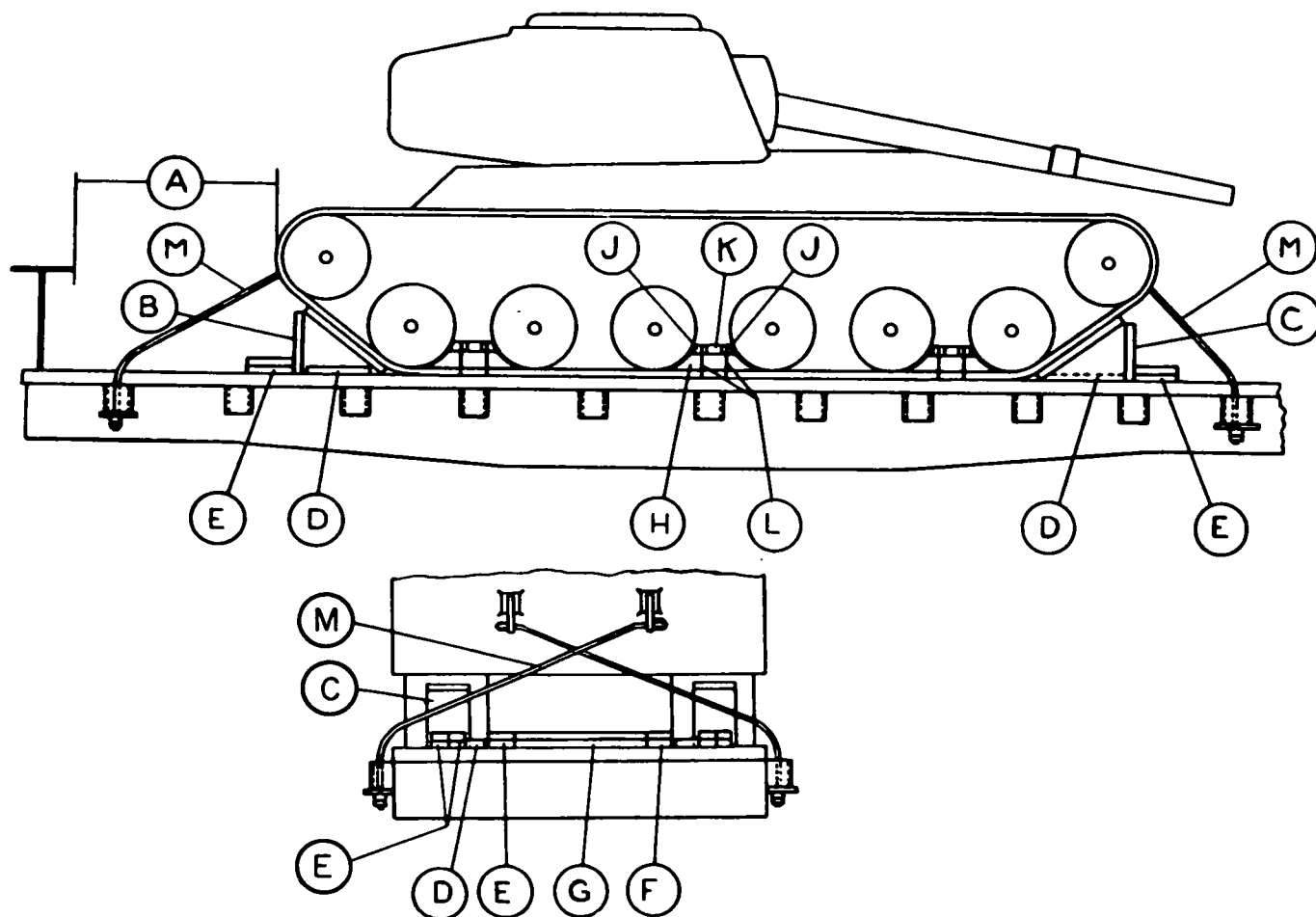


Figure 4-10. Loading a tank or similar unit, 60,000 to 100,000 pounds, on an open-top car.

Item	No. of pieces	Description	Item	No. of pieces	Description
		to floor or item B with five 30d nails and top piece to one below in like manner. Substitute, if desired, pattern 81 (fig 4-13).			lower piece to floor with 30d nails spaced about 12 inches apart and top piece to one below in like manner. Required only when units are loaded on floor of car.
J	6	2 by 8 by 13 inches. Locate as shown against items B and crawler, one near each end of unit and one at center. Secure each to item B with four 30d nails, and to item K with three 30d nails. Not required for units loaded on floor of car or when pattern 80 (fig 4-13) is used.	M	3	Each to consist of two pieces of lumber 2 by 4 inches, length to suit, suitably spaced between items L. Secure lower piece to floor with 30d nails and spaced about 12 inches apart and top piece to one below in like manner. Required only when units are loaded on floor of car.
K	3	4 by 6 inches, length equal to distance between items J. Not required for units loaded on floor of car. Substitute, if desired, pattern 80.	N	As required	Each to consist of two pieces of lumber 6 by 6 inches, length to suit, cut to fit contour of bogie wheels. Locate one piece between inside and outside wheels of each bogie assembly.
L	2	Each to consist of two pieces of lumber 2 inches by 4 inches by 14 feet. Locate against inside of crawler treads. Secure			

Item	No. of pieces	Description
O	1 each item N	2 by 4 inches, length to suit. Locate on top of item N, as shown, and secure with four 20d nails.
P	8	Rods 1¼ inches in diameter. Attach to lifting lugs and pass through stake-pockets and ½- by 4- by 10-inch plates underneath stake-pockets, as shown. Substitute, if desired, 6 x 19 IWRC wire rope, doubled.
Q	2	¾-inch steel cable, doubled. Locate, as shown, between gun turret and crawler structure.
R	2 each unit	¾-inch steel cable, 6 x 19 IWRC. Apply two ¾-inch cables in a complete loop securing gun barrel to unit at each side. Not required when unit is equipped with external built-in gun brace; however, if external gun brace is inoperative, cable will be used. Substitution of wire or banding is not authorized.

When necessary to extend floor to provide bearing for wheels or for the application of Items G on units loaded on floor of car, apply one piece of blacking on top of stake-pockets, long enough to extend beyond wheel chock blocks and high enough to be level with top of floor. Use 1- by 4-

¹ Turret gun should be in straight forward position; turret-lock handwheel and elevating mechanism-handwheel must be wired to prevent rotation.

² When tiedown rods are found slightly loose while in transit, they need not be tightened.

³ Hand brakes must not be set.

⁴ See General AAR rules for further details.

by 18-inch lumber at each end of blocking, nail each to floor with three 20d nails and to blocking with two 20d nails.

4-19. High and/or Wide Loads

a. Cars with high and/or wide loads may create an operating hazard: Both the cargo and the personnel working on the line can be endangered. Every possible effort must be made to reduce such hazards.

b. The transportation officer initiating a high and/or wide load is responsible for coordinating the shipment with the shipping agency to effect the maximum reductions possible; for example, the removal of spotlights and toolkits, the lowering of booms, and the depressing of gun barrels. Shipping configurations of major items of Army equipment are contained in TB 55-46-1.

c. When the movement of a high and/or wide load must be made, a scale drawing should be given the serving carrier to determine rail transportability and, if transportable, to make necessary routing instructions.

d. It is essential that the dimensions provided the carrier be accurate and that they reflect the absolute minimum that can be achieved by the shipping agency. (The consignee's ability to reassemble dismantled equipment must be considered.)

e. Whenever possible, an item of equipment should actually be measured to determine its shipping cube. Dimensions from supply manuals, TM,

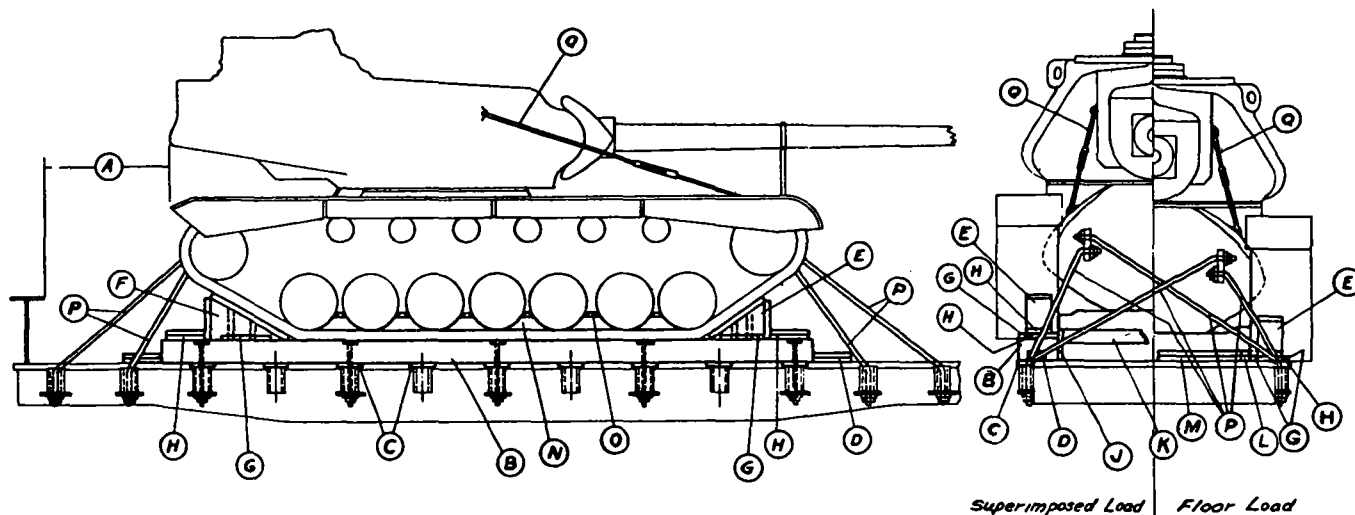


Figure 4-11. Loading tanks and similar units over 100,000 pounds on flatcars.

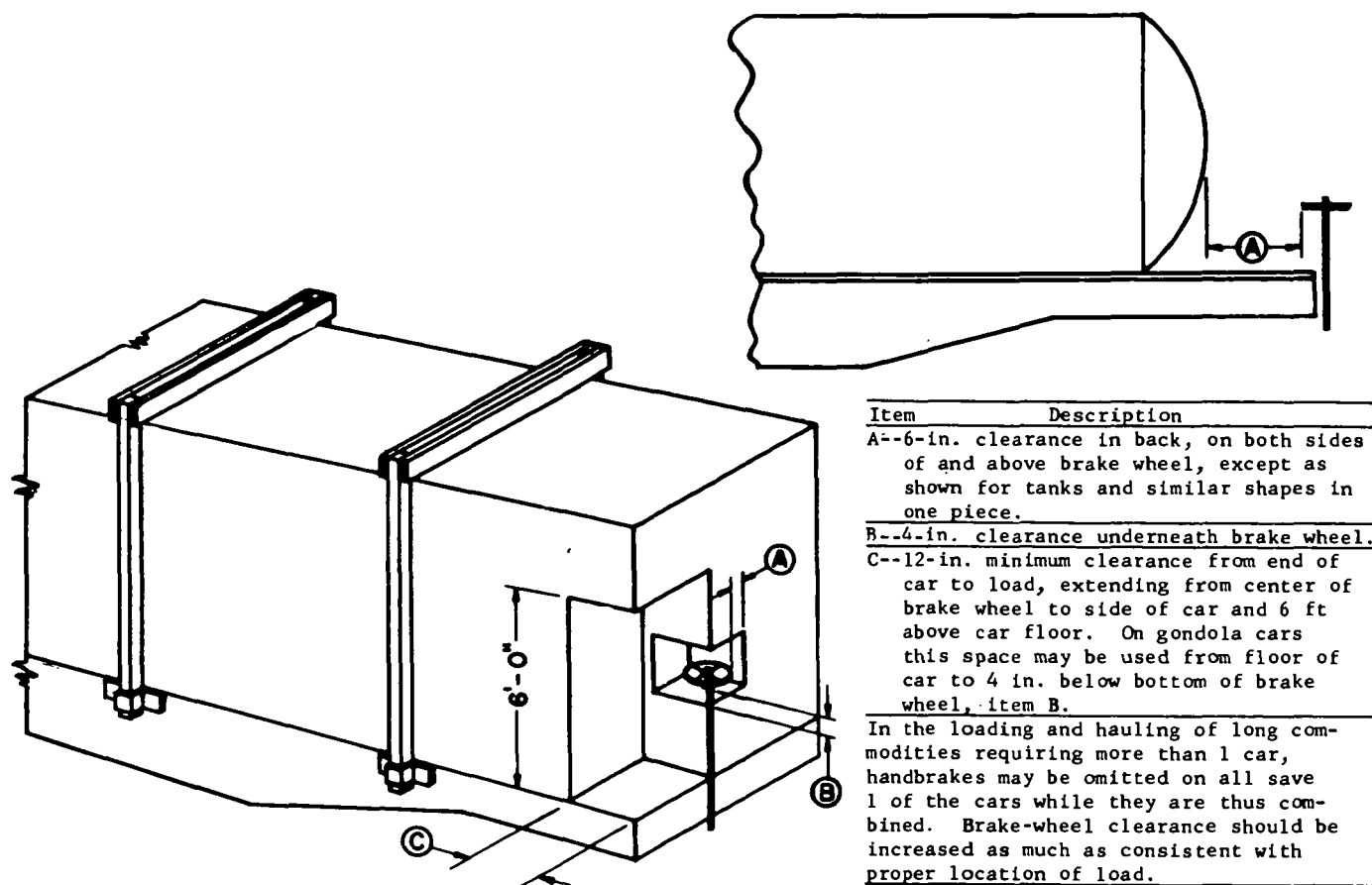


Figure 4-12. Brake-wheel clearance.

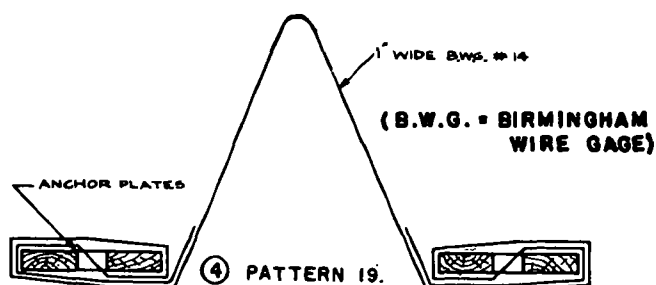
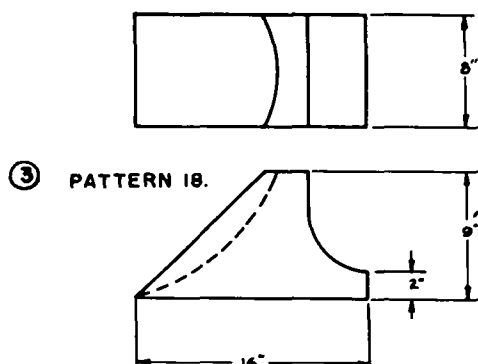
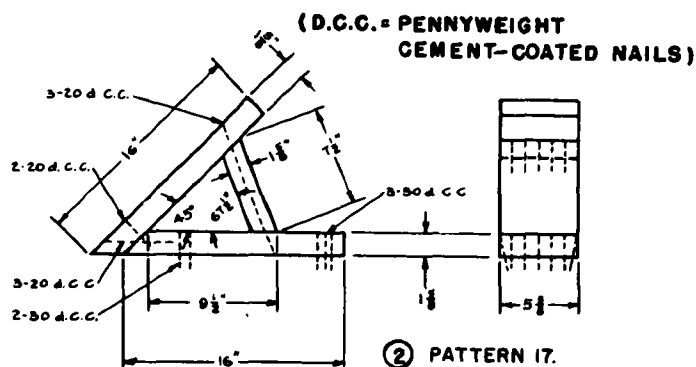
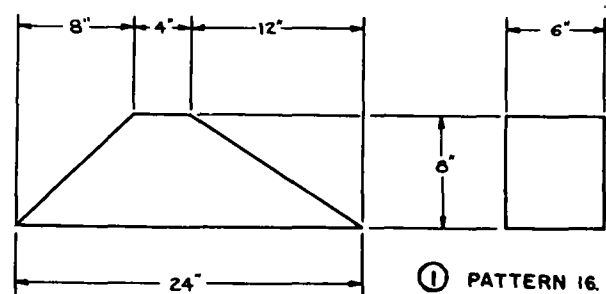


Figure 4-18. Chocks with dimensions and pattern numbers of the Association of American Railroads.

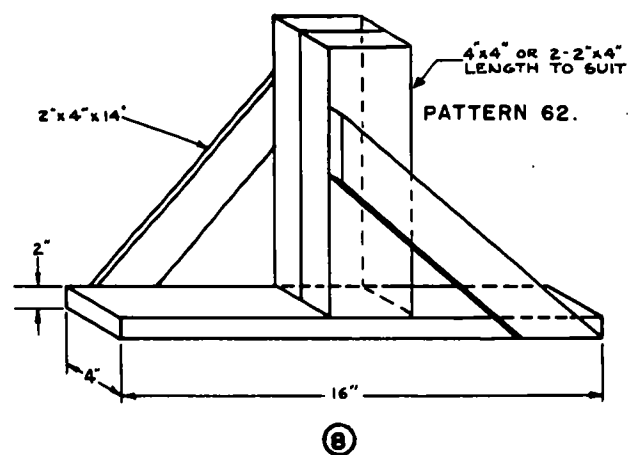
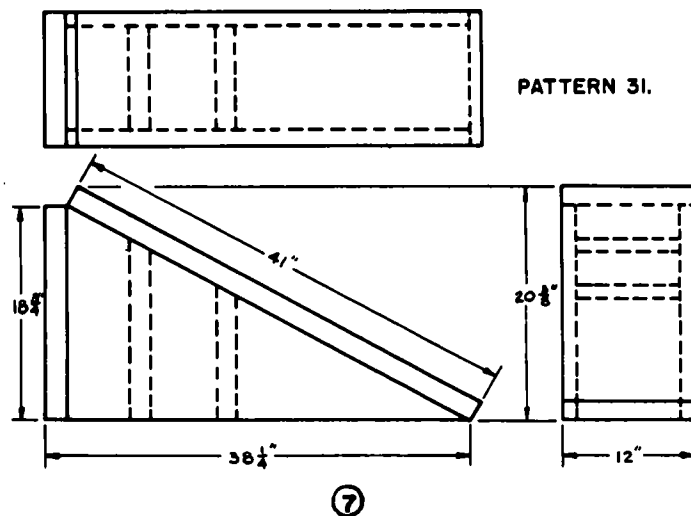
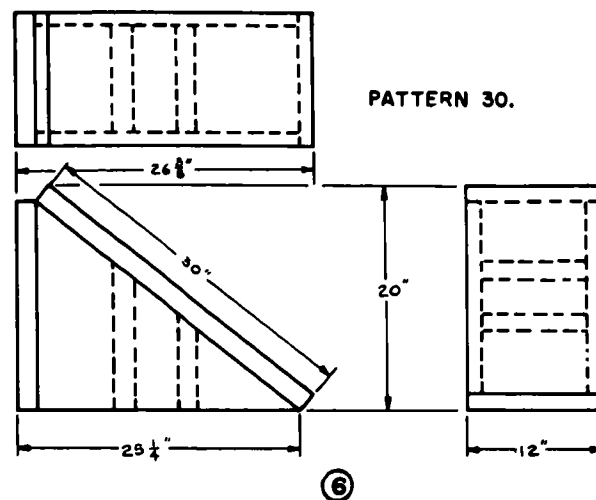
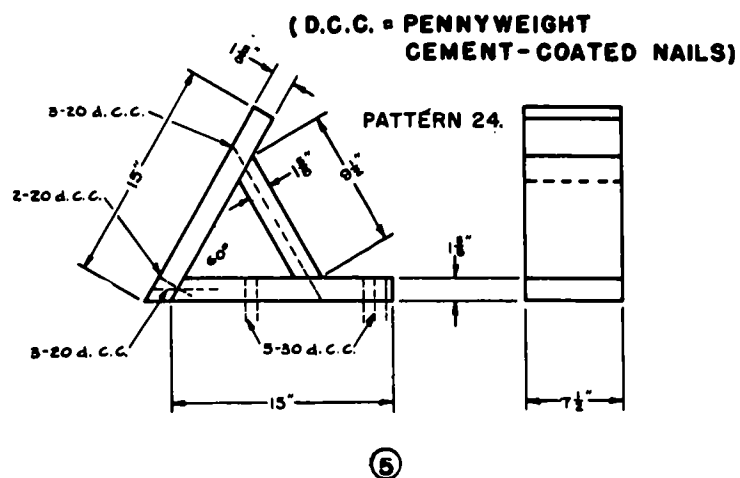


Figure 4-18—Continued.

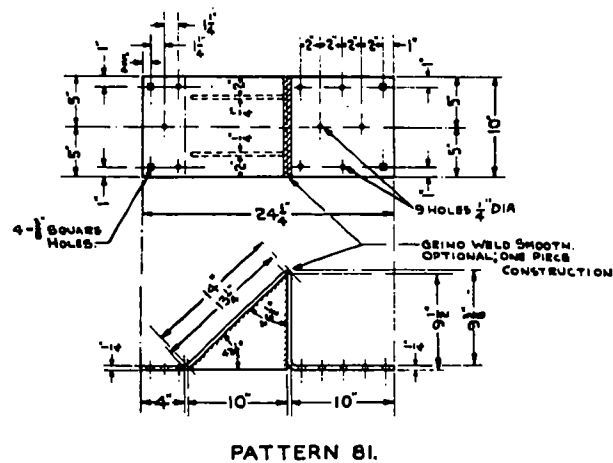
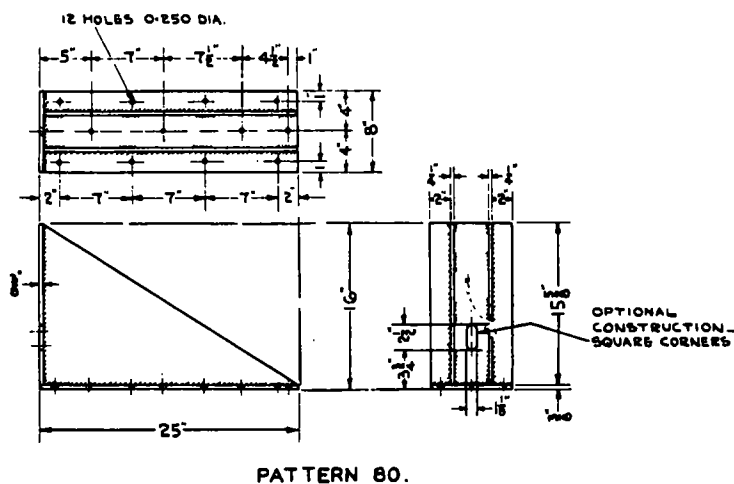


Figure 4-18—Continued.

FM, etc., should not be used without verification. Incorrect dimensions can be very dangerous and costly.

f. When moving outsize (high or wide) loads through areas of close clearances, such as low bridges or tunnels, building platforms close to the track, etc., trains should be operated at slow or reduced speeds; everyone concerned should be alerted to the movement.

4-20. Loading Explosives and Other Hazardous Materials

a. The authority and responsibilities of the DOT are established by Federal Law in Section 831-835, Title 18 of the US Code for the requirements governing the handling and transport of hazardous materials. These regulations are published in 49 CFR parts 170-179 and R. M. Graziano's Tariff Number 25 entitled "Hazardous Materials Regulations of the DOT." The DOT is responsible for the regulation of shipment and/or movement of all hazardous materials in interstate commerce by rail, air, highway and water through its major operating agencies. These regulations give requirements for classification, compatibility, packaging, marking, labeling, storage, and placarding of containers and vehicles for hazardous materials. Requirements for carriers of rail freight for loading, unloading, storage, marking, placarding, compatibility, and handling packages in cars are given in 49 CFR 174. These regulations cover minimum transportation requirements only. DOD and DA may supplement DOT requirements when deemed necessary. The transportation of military explosives and hazardous materials by either military carriers or commercial carriers within CONUS is governed by AR 55-355. AR 55-355 requires compliance with all regulations, reporting of accidents in accordance with AR 385-40, maintenance of records, tracing of shipments and completion of DD Form 6 and SF 361 when required, and insuring that security is maintained. AR 55-355 gives a list of AAR loading rules applicable to safe transportation. Approved military drawings for out-loading procedure will be complied with by the shipper. The use of placarding of containers and vehicles is given in AR 55-355. The marking of packages will be in accordance with MIL STD 129. The DOT regulations 49 CFR 173-56(C) and (C) (1) require approval of the Bureau of Explosives (Association of American Railroads) of all loading, blocking and bracing methods used for rail shipment of unboxed explosive projectiles, explosive torpedoes,

explosive mines or explosive bombs, exceeding 90 pounds in weight and explosive projectiles of not less than 4½-inches in diameter. Explosive projectile less than 4½-inches in diameter may be shipped without being boxed, when palletized, only for the military.

b. The transportation of explosives must conform to certain safety standards given by DOD and DOT. TM 9-1300-206 provides information on the care, handling, preservation, and destruction of ammunition. Quantity-distance standards for manufacture, handling, storage, compatibility, and transport of mass-detonating ammunition, explosives and ammunition are covered. Also, quantity-distance classes and tables for all classes of ammunition and explosives are given.

c. The Bureau of Explosives (AAR) pamphlet 6 illustrates methods for loading and bracing carload and less-than-carload shipments of explosives and other dangerous articles. Bureau of Explosives (AAR) pamphlet 6A illustrates methods for loading and bracing carload and less-than-carload shipments of loaded projectiles, loaded bombs, etc. B of E (AAR) pamphlet 6C illustrates methods for loading and bracing trailers and less than trailer shipments of explosives and other dangerous articles via trailer-on-flatcar (TOFC) or container-on-flatcar (COFC). Methods of bracing or blocking other than those given in the above pamphlets will be submitted to the Bureau of Explosives for approval.

d. Information to implement DOT regulations has been published in various AR and TM 55-602. The USAMC has published a number of outloading drawings for ammunition, missile systems, special weapons and other hazardous materials.

Basic precautions to be observed are as follows:

e. Lost space in loading packages in a car should be avoided by pressing each package firmly toward the end of the car as it is loaded.

f. High pressures on small areas must be avoided. The largest possible area of a package must be used to resist pressures. Beveled boards must be nailed to the car floor to cover defects in the floor or projecting pieces of metal or nails. Cars with corrugated or pressed metal ends, not lined, and cars with bowed ends must be boarded up at the inside of the ends to the height of the load.

g. Placing a large shipment in one end of a car must be avoided. A shipment in excess of 12,000 pounds must not be loaded in one end of a car

unless other freight is to be loaded in the other end to balance it. Failure to observe this precaution may cause the car to leave the track.

h. Bracing and blocking must be made with sound lumber, free from cross grain, knots, knot-holes, checks, or splits which impair the strength of the material or interfere with proper nailing.

i. Nails should be used plentifully and in the proper places.

(1) Balanced nailing is important. All nails should be of such length as to have the necessary holding power and ample penetration into car walls, floors, or other bracing and blocking. To obtain the greatest holding power, nails must be long enough to nearly penetrate but not protrude through the timber holding the point of the nail. Nails must not be large enough to cause splitting; they should not be placed along one grain of the wood. Whenever possible, nails should be driven straight—not toenailed. Brass or copper hammers should be used to nail braces around packages of explosives.

(2) The lining of cars is only three-quarters or seven-eighths of an inch thick and has little holding power for large nails. Therefore, nails holding sidewall blocking should be driven into the heavy uprights supporting the lining.

j. Noncompatible chemicals or explosives must not be loaded or stowed together.

k. The following must not be used:

(1) Cars with end doors.

(2) Cars with automobile loading devices unless the loading device is attached to the roof of the car so that it cannot fall (applicable to the shipment of class A explosives only).

(3) Refrigerator cars, except when—

(a) Authorized by the carrier or owner,

(b) Ice bunkers are protected by solid bracing, and

(c) Unfixed floor racks are removed.

l. When heavy loads are handled in and out of cars on lift trucks, a temporary steel plate or other floor protection of suitable size must be used to prevent the truck from breaking through the floor.

m. When loading in closed cars, the following safety rules must be followed:

(1) Lading must be so secured that it will not come in contact with side doors, or roll or shift in transit.

(2) Adequate stripping must be placed across

each door opening to prevent lading from falling, rolling out of a doorway, or coming in contact with a door while in transit.

(3) Load must be so placed in the car that there is not more weight on one side than on the other. One truck must not carry more than one-half the load limit stenciled on the car. Cars should be loaded as heavily as possible up to, but not exceeding, the load limit stenciled on the car. Loads should be placed in cars as shown in figure 4-14. The distances shown in the figure represent lengths of different loads. Relative position on the car of each load is also shown.

(4) Material loaded between truck centers and ends of car must not exceed 30 percent of the stenciled load limit (15 percent each end) when both ends are loaded and 10 percent when only one end is loaded. The percentage of stenciled load limits shown in figure 4-14 must not be exceeded for loads located between truck centers, measured lengthwise of car, except when car owner designates otherwise.

n. The following instructions apply in loading and blocking ammunition. (Less-than-carload shipments may be loaded and braced in the same manner.) All space between sides of car and rows of containers must be tightly wedged in place at time of loading. Bulkhead braces for partial layers must be long enough to permit nailing to upright braces behind car lining. Length will vary, depending on weight of lading supported. The filler strips nailed to the sides of the car must be extended across the doorway. No other doorway protection is required.

4-21. Marking Dangerous-Cargo Cars

a. Loaded Cars. Labels and placards required for containers and railcars used for transporting explosives and other hazardous materials are described in 49 CFR parts 172, 173 and 174. Explosives Class A placards must be rectangular in shape, measuring 11 by 14 inches and printed in red and black ink. Closed cars and tank cars containing dangerous loadings are marked with placards giving the contents. These cards, usually 10 to 14 inches square and printed with large red and black lettering, indicate the contents of the car and give special handling instructions. The placards usually are tacked to placard boards bolted to the outside of the car—one at each end and one on each door on each side of the car. Cars of all-steel construction often have a framed card pocket, one each in the four locations, enumerated, into which the printed placards are slipped.

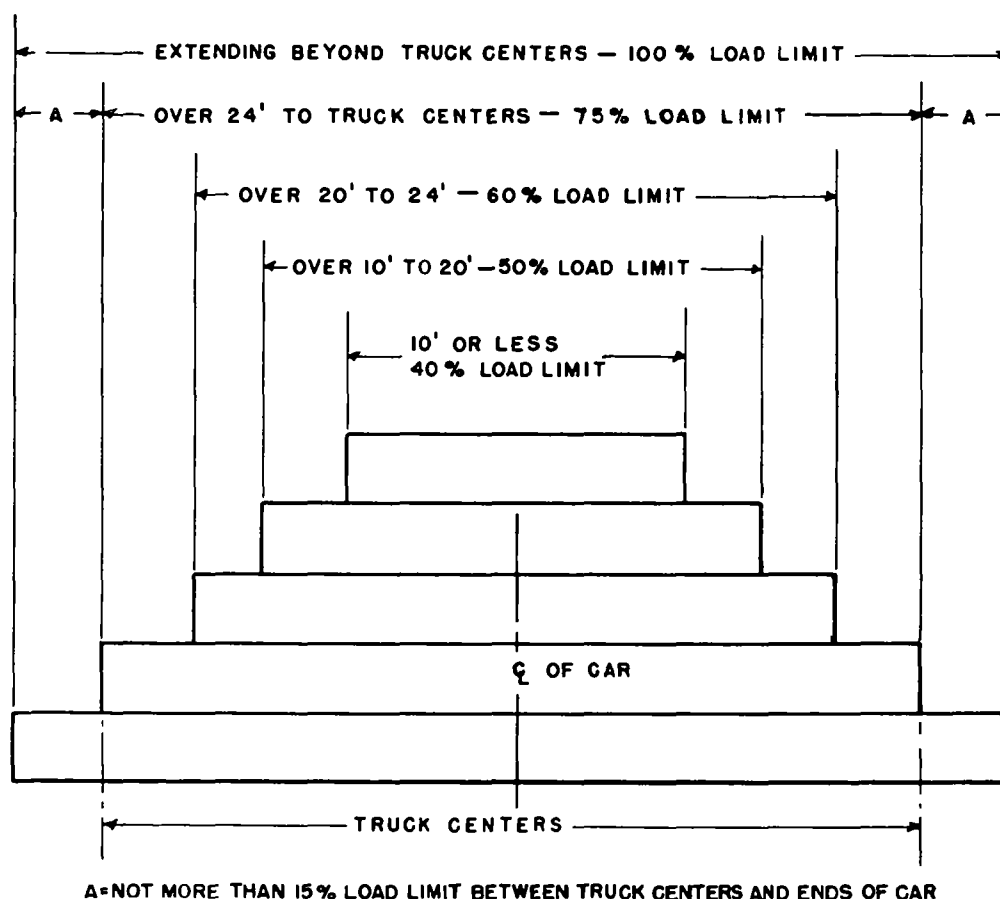


Figure 4-14. Load limits for explosives.

b. Empty Cars. Empty tank cars and boxcars are often placarded with notices that warn of lingering gases and fumes. These warning cards on cars stress that care must be used in switching the cars as well as in unloading their contents.

c. Examples. Typical car placards used on commercial and military railroads in the United States are shown in figures 4-15 through 4-18 and four-language placards for use by the Army in Europe are shown in figure 4-18.

4-22. Cargo Security

a. At Origin.

(1) The shipper is responsible for the security of carload freight until the car is coupled to a locomotive or train for movement. *The shipper must be fully aware of this responsibility.*

(2) Before loading, the shipper should inspect the car thoroughly to insure that it meets security requirements. Cars with holes or damaged places in floors, roofs, or sides, or insecure doors must be repaired before they are used.

(3) The shipper is responsible for properly

loading and bracing the load and for closing and sealing the car. Improperly stowed or braced loads may be damaged in movement and invite pilfering (TM 55-601).

(4) Loading should conform to the standards necessary for safe movement under existing operating conditions. In sealing closed cars, the best protection is provided by tightly twisting a 10-inch length of heavy-gage wire through the locking eyes and snubbing off the wire ends closely. Usually No. 8- or 10-gage wire is used. Zero-gage may be necessary when the pilferage or sabotage threat is acute. The door hasps of closed doors are always sealed with a thin, metallic seal on which a serial number is stamped. This seal is broken easily and provides little protection against pilferage; however, the absence or breakage of a seal indicates tampering. Shipments in open cars should be covered with securely fastened tarpaulins if required by nature of shipment. Small items shipped on flatcars should be fastened securely to the car floor.

(5) The shipper prepares an accurate list of

RAIL PLACARD

**DO NOT
REMAIN IN
OR NEAR THIS
CAR UNNECESSARILY**

**Notify Shipper or Bureau
of Explosives before handling
contents of broken packages.**

**DANGEROUS
RADIOACTIVE MATERIALS**

**This car must not be next to a car
placarded EXPLOSIVES or next to
carloads of undeveloped film.**

**Avoid contact with leaking
contents**

**WHEN LADING IS
REMOVED THIS
PLACARD
MUST BE
REMOVED**

Figure 4-15. Dangerous radioactive material placard, railcars.



Figure 4-16. Explosives placard, railcars.

contents, prepares the waybills, and affixes placards to the cars. After a car is loaded, sealed, and documented, it should be moved as quickly as possible.

(6) At military installations the originating transportation officer and railway personnel must inspect all open-top cars before movement to insure that they are loaded properly and meet clearance requirements.

b. In Transit.

(1) In CONUS the appropriate commercial railroad and in oversea theaters the transportation railway service is responsible for the security of all carload freight in transit from the time the car is moved from its loading point until it is placed at the designate unloading point. In CONUS the originating rail carrier and in oversea theaters the transportation railway service prepares all car records, train documents, and other records required to insure prompt movement and to prevent loss of cars en route. When operating conditions permit, cars containing freight subject to pilferage are grouped to permit economy in the use of guards. Special handling is given to mail or high-priority traffic of a classified nature.

(2) Train guards are provided by appropriate Army headquarters in CONUS. In oversea

theaters, train guards are provided by military police or other units assigned or attached to the transportation railway service for security duties. These units also guard cars and trains during movement in railroad yards. Sensitive supplies may be guarded by personnel assigned to the car by the loading agency. The yardmaster advises the dispatcher on receipt of cars with special guards. He also notes the receipt on the train consist that is transmitted to yards and terminals. This insures that all railway personnel avoid delays in transit and expedites placement at the destination.

(3) Guard crews check car seals and inspect trains for cars that are not secure. They prepare a record, by car number, of all guarded cars in trains, noting any deficiencies or incidents en route. When a relief guard takes over, the crews make a joint inspection and sign this record.

(4) When a bad-order car containing supplies subject to pilferage is set out, a member of the guard crew should remain with the car until he is properly relieved. Guard crews must be alert at all times, particularly when the train has stopped, and when it is passing through tunnels, cuts, and villages at slow speed.

c. At Destination.

(1) The consignee becomes responsible for



Figure 4-17. Radioactive material labels.

carload freight when it is placed at the depot, siding, or track he designates. Cars should be unloaded as quickly as possible to lessen chances for pilferage.

(2) In removing wire seals from closed cars, care must be taken to avoid breaking latches on the car door. Wire cutters are recommended for this purpose.

4-23. Troop Movements

a. Space Requirements. For planning purposes, the following capacity data may be used when loading troops on US equipment (other details contained in para 4-8 through 4-10, TM 55-604).

(1) *Sleeping cars (average).* Thirty-two troops with individual equipment.

(a) Officers and warrant officers are moved in standard pullmans, two per section, and are listed by number of sections; for example, 14 officers are shown as seven sections. Officers and

warrant officers of all units in one train will be grouped in one or more pullman cars as required.

(b) Enlisted men move in tourist pullmans, usually two per section. NCOs of the first five grades are entitled to separate berths. Space must be provided for personnel attached from medical units and men detached as guards on freight cars.

(2) *Coaches (average).* Fifty-five troops with individual equipment.

(3) *Passenger trains (long-distance moves, average).* Eleven sleeping cars, two kitchen cars, one or two baggage cars; 350 troops per train is typical.

(4) *Freight trains.* For troop-unit moves, including such heavy equipment as tanks, artillery, and engineer equipment, trains seldom exceed 65 cars (650 short tons) for infantry divisions; 55 cars (1,200 short tons) for armored divisions.

(5) *Mixed trains.* Desirable from a tactical



Figure 4-18. Railway car placards, US Army, Europe.

and organizational standpoint, since they carry all personnel with their vehicles, artillery, and equipment. Not economical when passenger equipment is in short supply because they move at freight train speed. In mixed trains, boxcars should be substituted for baggage cars.

(6) *Kitchen-baggage cars.* Furnished on the basis of one per 250 men or fraction thereof. Requirements per train depend upon how transportation is grouped. For tentative estimates, allow one per unit.

(7) *Flatcars.* Number required is computed on the basis of maximum utilization of each car, regardless of length. Computation is not restricted to cars of one length. Twelve inches if left clear at one end of each car for brake-wheel clearance.

b. Organizational Equipment.

(1) Amount of headquarters, kitchen, and maintenance equipment varies somewhat in all units. For planning, allow 20 short tons per company or equivalent unit.

(2) Organizational equipment is usually loaded in unit transportation; loading it separately requires more boxcars. Checkable baggage up to 150 pounds is carried free; generally, this is loaded in a baggage car or boxcar. When transportation groupings permit, checkable baggage for two companies or similar units may be loaded in one boxcar

c. Foreign Railways.

(1) Few foreign railways are capable of moving complete troop units by rail at the same time the rail net is supplying a major force. Accordingly, tracked vehicles and foot troops may move by rail while wheeled vehicles with their normal towed loads move on highways.

(2) For planning, the following capacities may be assumed:

(a) Freight cars.

Well flatcars	50 short tons
Medium flatcars	25 short tons
Small flatcars	12 short tons
Boxcars	10 short tons or 25 troops

(b) Passenger cars.

Coaches	40 troops
Sleeping cars	32 troops

4-24. Troop-Train Commanders

a. Assignment.

(1) An officer in charge of troops (train) is appointed or detailed for all troop trains. He is usually senior officer commanding troops. Duties are discussed in TM 55-604.

(a) If only one unit is involved, he may be detailed by headquarters of unit ordered to move.

(b) If more than one unit is moving, he may be appointed by transportation movements officer at entrainment station unless an officer has been appointed by higher headquarters.

(2) If the troops are of mixed nationalities, the senior officer commanding troops, regardless of nationality, is troop-train commander; in cases of equal senior rank, the commander of largest number of troops served will be the troop-train commander.

(3) He serves until journey is completed, regardless of officers boarding train en route.

b. Duties.

(1) *Administration.* The troop train commander—

(a) May appoint one or more officers as assistants. When troops of other nationalities are traveling on same train, officers of the nationalities concerned are appointed as assistants.

(b) Complies with instructions received en route from the responsible transportation movements officer.

(c) Ascertains details of loading baggage, vehicles (if any), and personnel from transportation movements officer, stationmaster, or port commander if moving from a port.

(d) Submits troop-movement order to transportation movements officer.

(e) Makes location of troop-train commander's headquarters on train known to all troops.

(f) Gives order of entrainment; directs entrainment, noting location of various units and their baggage.

(2) *Discipline.* The troop-train commander—

(a) Is responsible for the protection, discipline, and conduct of all troops aboard the train.

(b) Directs that separate accommodations be provided for all females traveling; details an officer to any car in which separate compartments are occupied by male and female personnel to insure observance of proprieties.

(c) Issues orders that prohibit—

1. Discussing the move with unauthorized persons.

2. Detraining without orders.

3. Throwing rubbish out of windows.

4. Leaning out of windows.

5. Damaging railway property.

6. Marking or writing on side of cars.

7. Violating blackout.

8. Wasting water in lavatories.

9. Riding on trains except where authorized.

10. Using intoxicants.

11. Using train latrines while in stations.

(3) *Sanitation.* The troop-train commander is advised by train crew of—

(a) Approximate time and duration of rest stops to be made during a long journey.

(b) Whistle signal to be used for notification of such stops.

(4) *Air defense.* The troop-train commander will—

(a) Interrupt movement program only if assault is specifically directed against the destination station.

(b) Be prepared to assist local anti-aircraft after consultation with transportation movements officer.

(c) Enforce blackout.

(5) *Defense against ground attack.* This will depend upon the area involved, type and degree of attack, and the forces available to the troop-train commander. He should follow instructions and/or SOP provided by the local commander.

4-25. Estimating Railway Capacity

Since the direction of military supply movements is primarily forward, military rail line capacity estimates generally are based on net tonnage moved in one direction. However, total capacity is based on train density and the movements of trains in both directions must be considered. When the railway net under consideration is composed of several divisions and branch lines, separate estimates should be made for each division and branch line. In estimating railway line capacity in terms of payload hauled, the limiting factors are the power of the locomotive and resistance offered by the grade, the curve, the locomotive, the cars, the lading, and the weather. The formulas and factors presented in the following paragraphs are listed in the order in which they must be considered.

4-26. Weight on Drivers

a. General. The weight on drivers of a locomotive is expressed in short tons. It is that weight which is supported by the coupled driving wheels when they rest on a straight and level track. It does not include any of the remaining portion of the locomotive's weight. Different types and classes of locomotives differ in weight. All locomotives are constructed to specifications issued by the purchaser, the using railroad, or the manufacturer.

b. Army Locomotives. The weights on drivers of some common types of diesel-electric locomotive

tives used by the Department of the Army are included herein for ready reference. A complete table of Army locomotive characteristics is contained in table C-1, FM 55-20.

Type	Weight on Drivers (ston)	Horsepower
0-6-6-0, standard-gage -----	131	1600
0-6-6-0, multigage -----	127	1600
0-4-4-0, standard-gage -----	120	1200
0-4-4-0, standard-gage -----	120	1500
0-4-4-0, standard-gage -----	80	1000

4-27. Tractive Effort (TE)

a. General. Tractive effort is a measure of the potential power of a locomotive expressed in pounds; it is the horizontal force which a locomotive can exert if the wheels do not slip. A locomotive's tractive effort is included in the data supplied by the manufacturer. The tractive effort of some locomotives used by the Department of the Army may be found in table C-1, FM 55-20. When such data are not available, tractive effort can be computed using the formulas in *c* below. Due consideration must be given to the locomotive's age and condition.

b. Starting and Continuous Tractive Effort. Starting tractive effort is the power that a locomotive has available to move itself and the load it is hauling from a stopped position. Continuous tractive effort is the effort required to keep a train rolling after it has been started. As the train increases in momentum, the tractive effort needed diminishes rapidly. In steam locomotives no differentiation is made between starting and continuous tractive effort. A steam locomotive can generally continue to pull what it can start. However, a diesel-electric locomotive cannot continue to exert the same force achieved in starting without damaging its power unit. The continuous tractive effort of a diesel-electric locomotive is approximately 50 percent of its starting tractive effort.

c. Rule-of-Thumb Method of Determining Tractive Effort.

(1) Starting tractive effort is closely correlated to the adhesion which the driving wheels maintain at the rails. If the tractive effort expended exceeds this adhesion element, the drivers will slip. Normally, the adhesion element when the rails are dry is 30 percent of the weight on drivers; when the rails are wet, 20 percent. Therefore, 25 percent is taken as the average.

(2) Thus, for a locomotive weighing 80 tons

or 160,000 pounds on drivers, the approximate starting tractive effort would be $\frac{160,000}{4}$ or 40,000 pounds.

(3) If it were a steam locomotive, the continuous tractive effort of the above locomotive would also be 40,000 pounds. If it were a diesel-electric locomotive the continuous tractive effort would be approximately $\frac{40,000}{2}$ or 20,000 pounds.

4-28. Drawbar Pull

a. General. Drawbar pull is the actual pulling ability of a locomotive, less the effort necessary to move the locomotive. Actual tests have indicated that 16 to 20 pounds of pull per ton are required to start the average locomotive or freight car on straight, level track under favorable weather and temperature conditions. A locomotive or car equipped with roller bearings will start with somewhat less effort. For railway planning, 20 pounds per ton should be used. This resistance drops after equipment starts rolling; but to establish pulling ability (drawbar pull) available for starting and pulling a train, 20 pounds per ton of locomotive weight should be subtracted from the continuous tractive effort of the locomotive. Thus, a diesel-electric locomotive weighing 80 tons on drivers and having a continuous tractive effort of 20,000 pounds has a drawbar pull of 18,400 pounds (20,000 pounds minus 1,600 pounds).

b. Speed Factors. Maximum drawbar pull can be exerted only at lowest speeds—up to approximately 10 miles per hour—after which it drops off sharply. Drawbar pull at given speeds can be obtained by applying a speed factor to the maximum drawbar pull. However, speeds are different for different types of locomotives. In one type of steam locomotive, drawbar pull was found to diminish in inverse ratio to speed. For example, drawbar pull is 80 percent at 20 miles per hour, 50 percent at 50 miles per hour, and 20 percent at 80 miles per hour. This may be used as a rule-of-thumb for estimating drawbar pull of steam locomotives at various speeds. The drawbar pull of diesel-electric locomotives diminishes more rapidly at the higher speeds.

4-29. Rolling Resistance

The force components acting upon a train in a direction parallel with the track which tend to hold or retard the train's movement constitute rolling resistance. The components of rolling re-

sistance are friction between the railheads and the treads and flanges of the wheels, resistance due to undulation of track under a moving train, internal friction of rolling stock, and resistance in still air. An absolute figure to be used as rolling resistance is unknown. Experience indicates that a safe average value to use in the theater of operations for rolling resistance is as shown below:

Pounds per ton of train	Track condition
5 -----	Excellent
6 -----	Good to fair
7 -----	Fair to poor
8 -----	Poor
9-10 -----	Very poor

4-30. Grade Resistance

As determined by the following formula, grade resistance is equal to 20 pounds per ton of train times the rate percent of grade.

$$RG = \frac{WR}{B}$$

Where Rg = grade resistance
 W = 1 ton (2,000 pounds)
 R = rate percent of grade
 B = one station (100 feet)

Thus, Rg in pounds per ton may be expressed

$$Rg = \frac{2,000 \times \text{percent of grade}}{100}$$

4-31. Curve Resistance

No entirely satisfactory theoretical discussion of curve resistance has been published; however, engineers in the United States usually allow from 0.8 to 1 pound per degree of curve. In military railway planning, the factor 0.8 pound per ton of train per degree of curve is used. The continual passing of trains around a curve eventually moves the track, which disturbs alinement and distorts the curve. The track should be restored to its correct curvature after determining whether any distortion exists. This should be done by TRS maintenance-of-way personnel. A field expedient for determining the curvature of a track is the string method (para 4-45).

4-32. Weather Factor

a. The weather factor is another expression of train resistance. It reflects, by percentage, the effects of adverse cold and wet weather upon actual hauling power of a locomotive. Experience and tests have proved that whenever the temperature drops below 32° F., the hauling power of the locomotive is decreased. Table C-3, FM 55-20, shows

the weather factor (percent) for different degrees of temperature.

b. Ordinarily, wet weather is regarded as local and temporary and is disregarded in normal planning. However, in countries of extended wet seasons the loss of tractive effort due to slippery rail may prove serious if sanding facilities are inadequate. The applicable reduction is a matter of judgment but, in general, tractive effort will not be less than 20 percent of weight on drivers.

4-33. Gross Trailing Load (GTL)

Gross trailing load is the maximum tonnage that a locomotive can move under given conditions, i.e., curvature, grade, and weather. It is determined by combining all of the factors discussed in the preceding paragraphs. When double-heading with steam locomotives or using pushers, the GTL is equal to the sum or the GTL of the two locomotives (or 100 percent of the total GTL for diesel-electric locomotives). The formula for gross trailing load is as follows:

$$GTL = \frac{DBP \times W}{RR + GR + CR}$$

Where GTL = gross trailing load
 DBP = drawbar pull
 W = weather resistance
 RR = rolling resistance
 GR = grade resistance
 CR = curve resistance

4-34. Net Trainload (NTL)

Net trainload is the payload carried by the train. The total weight of cars under load is gross weight. The light weight, or weight of cars empty, is tare. The difference between these two is the net load or payload of the train. In military railway planning, the net trainload is taken as 50 percent of the gross trailing load.

4-35. Train Density (TD)

a. General.

(1) The term train density is used to denote the number of trains that may be operated safely over a division in each direction during a 24-hour period. Work trains are not included in computing train density. However, their presence on divisions, and the amount of time they block the main track, can reduce the density of a rail division. Train density may vary greatly over various divisions due to the condition and length of the main line, number and location of passing tracks, yard and terminal facilities, train movement control

facilities and procedures, availability of train crews, motive power, and rolling stock.

(2) On a single-track line, passing tracks are normally 6 to 8 miles apart. When multiple tracks (three or more) are encountered, they are generally considered as double track since it is frequently necessary to remove a portion of the third and fourth tracks in order to maintain the double track line.

(3) The capacity or operating turnover of cars and trains in and out of terminal yards must be considered, either from definite experience and intelligence factors or by inference from other related information.

(4) The following rule-of-thumb and formula are primarily designed to determine freight train density; however, they will be reasonably accurate on lines having 20 percent passenger trains included.

b. Rule-of-Thumb for Determining Train Density. In the absence of sufficient intelligence upon which to evaluate the potential train density of a rail line, a train density of 10 for single track and 15 for double track should be used as planning factors.

c. Formula for Determining Single-Track Train Density. When sufficient operational intelligence is available, the following formula and factors may be used in determining train density for a specified railway division. In determining the number of passing tracks, those less than 5 miles apart should not be included. Passing tracks selected should be uniformly spaced throughout the division.

$$TD = \frac{NT + 1}{2} \times \frac{24 \times S}{LD}$$

Where TD = train density

NT = number of passing tracks

1 = constant (number of trains that could be run if there were no passing tracks)

2 = constant to convert to one direction

24 = constant (number of hours per day)

S = average speed (table C-4, FM 55-20)

LD = length of division

d. Formula for Determining Double-Track Train Density. In determining the train density for double-track operations, fluidity and flexibility must be maintained. Thus, the number of trains operated should not exceed that number which can be cleared off either main track in case of emergency at any given time. Using the factors in c, above, train density for double track may be computed as follows:

$$TD_2 = (NT + 1) \times \frac{24 \times S}{LD}$$

4-36. Net Division Tonnage (NDT)

a. Net division tonnage is the tonnage in short tons, or payload which can be moved over a railway division (90-150 miles) each day. It includes railway operating supplies which must be programmed for movement the same as the supplies of any other service.

b. Net division tonnage is determined by multiplying the net trainload (NTL) by the train density (TD) of the particular division. Net division tonnage is computed separately for each division.

c. When calculating net division tonnage, certain other factors must be taken into consideration. For example, troop, passenger, or hospital trains will replace an equal number of tonnage freight trains. When the operation of such trains is anticipated, allowance in net division tonnage estimates is made by adjusting the train densities of the divisions concerned.

4-37. End Delivery Tonnage

In military operations, the end delivery tonnage measured in short tons which is delivered at the end of the railway line (railhead) each day. In all all-rail movement, the end delivery tonnage is the same as the net division tonnage of the more restrictive division.

4-38. Miscellaneous Operational Values

a. Effect of Temperature on Hauling Power of Locomotives.

Temperature (°F)	Loss in hauling power (percent)
Above + 32	0
+31 to +16	5
+15 to 0	10
-1 to -10	15
-11 to -20	20
-21 to -25	25
-26 to -30	30
-31 to -35	35
-36 to -40	40
-41 to -45	45
-46 to -50	50
-21 to -25	25
-26 to -30	30
-31 to -35	35
-36 to -40	40
-41 to -45	45
-46 to -50	50

b. Average Rolling Resistance Values.

Condition of truck	Pound per ton of train
Exceptionally good -----	5
Good to fair -----	6
Fair to poor -----	7
Poor -----	8
Very poor -----	9 to 10

c. Terminal Times.

Type of locomotive	Hours
Steam -----	8
Diesel-electric -----	3

*d. Rolling Stock.**(1) Freight.*

(a) Requirements are computed separately for operations between major supply installations or areas on each line of communication as follows:

b. Average Rolling Resistance Values.

Condition of truck	Pound per ton of train
Exceptionally good -----	5
Good to fair -----	6
Fair to poor -----	7
Poor -----	8
Very poor -----	9 to 10

c. Terminal Times.

Type of locomotive	Hours
Steam -----	8
Diesel-electric -----	3

*d. Rolling Stock.**(1) Freight.*

(a) Requirements are computed separately for operations between major supply installations or areas on each line of communication as follows:

$$\frac{\text{Daily tonnage}}{\text{Average tons per car}} \times \text{turnaround time} = \text{number of cars}$$

Turnaround time is the total estimated number of days required for a car from the time it is placed for loading at its point of origin, moved to its destination, unloaded, and returned to its point of origin. Such time may be computed as follows: Allow 2 days at origin, 1 day at destination, and 2 days' transit time for each division, or major portion thereof, which the cars must traverse. This method, rather than an actual hour basis, is used to incorporate delays due to terminal and way-station switching as well as intransit rehandling of trains.

Location or type of operation	Rolling stock Days' dispatch required
At base of operation -----	2
Forward traffic -----	1 per division
Return traffic -----	1 per division
At railhead -----	1

(b) Computations should be increased by 10 percent to meet operational peaks, commitments for certain classes of cars, and bad order cars.

(c) An average planning factor for net load per car may be assumed as follows:

Standard gage to broad gage	
US equipment -----	20 tons
Foreign equipment -----	10 tons

Narrow gage	
US equipment -----	15 tons
Foreign equipment -----	7½ tons

(d) Tank car requirements are computed separately based on the bulk POL requirement and the computed turnaround time.

(2) Passenger.

(a) Passenger car requirements will vary, depending on troop movement policies, evacuation policies, and rest and recuperation policies.

(b) Theater passenger car requirements are fulfilled by acquisition of local equipment with the exception of hospital cars and trains.

e. Road Locomotives. The number of road locomotives required for operation over a given railway division may be determined by the following formula:

$$\frac{\text{Road locomotives required: } TD \times (RT + TT) \times 2 \times 1.20}{24}$$

Where TD = train density

RT = running time (length of division divided by average speed)

TT = terminal time (time for servicing and turning locomotive)

24 = number of hours per day

2 = constant for two-way traffic

1.20 = constant allowing 20 percent reserve

Note. The expression RT + TT is the percent of time during a 24-hour period in which a road locomotive is in use and is called the locomotive factor. The expression provides for the pooled use of motive power which may make one or more trips per day over a short division.

f. Switch Engines.

(1) The number of switch engines required at a terminal is based on the number of cars dispatched and received, or passing through the terminal per day. When the number of cars has been computed, that figure is applied to the table in (2) below to determine the number of switch engines required at each terminal.

(2) When the total number of switch engines required for the railway line has been computed, add 20 percent as a reserve to allow for maintenance, operational peaks, etc.

Switch engines

Type of terminal

Number of engines

Port, railhead, loading, unloading..... 1 per 67 cars dispatched and received per day
 Division..... 1 per 100 cars passing per day

g. Fuel Requirements.

Type of locomotive	Type of operation	Estimated average rate of fuel consumption					
		Per train mile				Per hour	
		Coal (lb)	Oil (lb)	Oil (gal)	Coal (lb)	Oil (lb)	Oil (gal)
Steam (coal-burning)							
2-8-0, 82-ton, standard gage.....	Road.....	90			700		
2-8-0, 90-ton, standard gage.....		115			950		
2-8-2, 60-ton, narrow gage.....	Road.....	100			750		
Steam (oil-burning)							
2-8-0, 82-ton, standard gage.....	Road.....		55			450	
2-8-2, 60-ton, narrow gage.....	Road.....		60			500	
Diesel-electric							
0-6-6-0, 120-ton, standard gage.....	Road switcher.....			2.5			11.5
0-4-4-0, 60-ton, standard gage.....	Road switcher.....			0.9			8.0
0-6-6-0, 80-ton, narrow gage.....	Road switcher.....			1.5			10.0
0-4-4-0, 48-ton, narrow gage.....	Road switcher.....			0.9			8.0

h. Determining Average Speed Values. For planning purposes, average speed values can be estimated by using the table below. To determine speed, select the most restrictive factor of the eight factors shown. If the restrictive factor(s) is not known, use an average speed value of 8 mph (13 kmph) for a single track and 10 mph (16 kmph) for double track. If the most restrictive factor affects only a comparatively short distance (10 percent or less) of the division, use the next higher average speed. If the average speed falls below 6 mph (10 kmph) because of the gradient,

reduce tonnage to increase speed. (A 2-percent reduction in gross tonnage increases speed 1 mile per hour.) If the ruling grade materially affects the tonnage, consider using helper service.

<i>Restrictive factors</i>		<i>Average speed</i>			
<i>Condition of track</i>	<i>Percent of grade</i>	<i>Single track</i>		<i>Double track</i>	
		<i>mph</i>	<i>kmph</i>	<i>mph</i>	<i>kmph</i>
Exceptionally good	1 or less	12	19.3	14	22.5
Good to fair ----	1 to 1.5	10	16.1	12	19.3
Fair to poor ----	1.5 to 2.5	8	12.9	10	16.1
Poor -----	2.5 to 3	6	9.6	8	12.9

Section IV. CONSTRUCTION, MAINTENANCE, AND SUPPLY

4-39. Construction Requirements

a. New Construction.

(1) New construction is an engineer responsibility, discussed in detail in TM 5-370. For planning purposes, a railroad division includes 100 principal-route miles of main line, single- or double-track, with its terminal operating and maintenance facilities, fueling and watering facilities, and the signaling equipment or interlocking facilities necessary for safe operation. Passing sidings on single-track lines, crossovers on double-track lines, and stations are located at intervals as re-

quired by traffic. Normally, at least one spur or siding is provided at each station. The engineer service in the theater of operations is responsible for new rail construction and large-scale rehabilitation. Transportation railway service maintenance-of-way personnel, however, may be required to assist engineer personnel in the latter work.

(2) The following table shows the materials and net effective man-hours required for new construction of 1 mile of standard-gage (56½-inch), single-track railroad.

Item	Short tons	Measurement tons	Man-hours
Grading, includes clearing average wooded terrain.....			5,000
Ballast delivered, average haul—5 miles (8.05 km).....			2,500
Track laying and surfacing.....			3,400
Bridging—70 linear feet (21.34 m).....	128	111	3,200
Culverts—7 per mile—280 feet (85.34 m).....	8	7	1,400
Ties—2,900.....	218	300	
Rail— 90 pounds—ARA—A Section.....	79	45	
115 pounds—ARA—E Section.....	103	57	
Fastening (based on 39-foot rail) (11.89 m).....	33	10	
Total.....	569	530	15,500

b. Rehabilitation. The following chart reflects the rehabilitation requirements that can be anticipated for a 100-mile (161-km) standard-gage, single-track division extending inland from a port, using average percentage of demolition over the entire division. For further information, see FM 55-20 and FM 5-35.

Item	Per 100 miles (161 km)	Percent of demolition	Rehabilitation (quantity)	Construction material ¹		
				Short tons	Measurement tons	Man-hours ¹ (thousands)
Main line trackage.....	100 mi	10	7.0 mi	2,708	1,033	36.4
Port trackage ²		100	3 mi	1,368	1,092	14.4
Passing sidings ²	2.4 mi	80	2.4 mi	1,049	874	11.5
Station sidings ²	1.6 mi	80	1.6 mi	730	582	7.7
Railway terminal ^{2, 3}	1 ea	75	0.75 ea	8,025	4,875	160
Water stations.....	3 ea	100	3 ea	135	210	9
Fuel stations.....	1 ea	100	1 ea	19	16	.9
Bridging (70 ft per mile).....	7,000	55	2,700 linear feet	2,700	2,672	70
Culverts.....	28,000 linear feet	15	4,200 (74 ea) linear feet	63	63	13.7
Grading and ballast.....						40.5

¹ Tunnels require special consideration. To repair (by timbering) a 50-foot demolition at each end of a single-track tunnel (100 ft total per tunnel), allow 70 short tons or 87 measurement tons, and 3,000 man-hours.

² Estimate includes ties, rails, fastenings, turnouts, tracklaying and surfacing. It is assumed ballast is available at worksites.

³ Includes replacement of buildings 100 percent, ties 30 percent, rail and turnouts 85 percent.

4-40. Maintenance Responsibilities

a. After railways are constructed and turned over to the transportation railway service for operation, minor railway maintenance in the communications zone and in the combat zone to the forward limit of traffic is the responsibility of the transportation railway service. This is discussed in TM 55-204.

b. The transportation railway service is responsible for the maintenance of the railway communications circuits that are used exclusively for the operation and administration of the railways. This responsibility becomes effective when all the circuits on the line have been turned over to the transportation railway service for administration and operation. The transportation railway service is responsible for the operation and for the organizational and direct support of railway block signals, of interlocking plants, and of centralized traffic control devices. It is also responsible for the installation, maintenance, and operation of internal communications.

c. The transportation railway system is normally divided into a number of divisions for maintenance and operation. Each division is assigned a railway battalion; each battalion includes personnel from the railway engineering company to perform necessary maintenance of tracks and structures.

d. The battalion commander has overall responsibility for railway maintenance, including maintenance work, instructions, and procedures. The company commander of the railway engineering company is maintenance-of-way superintendent and is directly responsible for the maintenance of tracks and structures, for the proper supervision of all maintenance work and procedures, and for the necessary inspection of track and structures on the division. Platoon and section leaders are charged with the proper supervision of assigned maintenance operations.

4-41. Maintenance Categories

a. *General.* Army maintenance is divided into four categories: organizational, direct support, general support, and depot.

b. *Locomotives.*

(1) Organizational maintenance consists of during-operation maintenance, inspection of visible moving parts, lubrication, and repair or replacement of parts whose condition might interfere with the efficient operation of the equipment.

During-operation maintenance is performed by the railway operating company, the balance is performed by the railway equipment maintenance company.

(2) Direct support maintenance is performed by the mobile railway workshop in the forward area and by the railway equipment maintenance company in the rear areas. When the repairs are not too extensive, the locomotive is repaired and put back into service. If the repairs are beyond the capabilities of the railway workshop, only those repairs will be made that are necessary to move the locomotive to a fixed installation for repair.

(3) General support maintenance and limited depot maintenance are performed by the diesel-electric locomotive repair company.

(4) There are no units provided in the transportation railway service for the performance of full depot maintenance. This category of maintenance beyond the capabilities of the railway car repair company and diesel-electric locomotive repair company will normally require evacuation to CONUS or to an appropriate base or facility.

c. *Rolling Stock.*

(1) Normally the railway battalion's train maintenance sections and crews perform organizational and direct support maintenance; this includes running repairs and inspection of rolling stock. The railway repair car companies are responsible for general support and limited depot maintenance.

(2) Organizational maintenance is performed at the originating point of the train and at inspection points en route by military car inspectors or civilian railroad personnel. It consists of making running repairs required for the safe operation of the train.

(3) Direct support maintenance is performed by maintenance personnel, either military or civilian, at the home terminals of the cars or at a prescribed location. It consists of running and emergency repairs that necessitate taking the car out of service for a short time (TM 55-203).

(4) Repair track installations (rip tracks) normally are set up at main terminals. Usually they are also necessary at other points on the division, such as function points or heavy loading centers, to take care of repairs that cannot be made at the loading installation and to avoid moving the cars into the main terminal. The master mechanic (railway equipment company commander) is responsible for the operation of the repair-track installation.

4-42. Inspection and Maintenance of Locomotives

a. Basic Principles.

(1) Suitable inspection pits and facilities must be provided for inspection, repair, and adjustment of parts.

(2) The engineman is responsible for the equipment he operates.

(3) The fireman is responsible for maintaining the proper water level and steam pressure on steam locomotives. He receives instructions from the engineman, has immediate superior.

(4) Each locomotive must be inspected daily, or at the end of each trip, and DA Form 55-226 must be completed for steam locomotives; DD Form 862 F or diesel-electric locomotives.

(5) Each locomotive must be inspected every 30 days and DA Form 55-227 completed for steam locomotives; DD Form 1336 for diesel-electric locomotives.

(6) In addition to the daily and 30-day inspections, each locomotive must be inspected semiannually and annually. Maintenance documentation will be in accordance with TM-series rail maintenance manuals.

b. Enginehouses. The two general types of enginehouses are turnaround and maintenance. The turnaround enginehouse is small and is only equipped with facilities for performing minor repairs and services. Work done in this enginehouse usually requires only 1½ to 3 hours. The maintenance enginehouse has facilities for making major as well as minor repairs; here the division locomotives are maintained in good operating condition and kept at maximum availability. TM 55-201 (steam locomotives) and TM 55-202 (diesel-electric locomotives) are general references covering maintenance procedures at enginehouses.

4-43. Maintenance of Way

a. Roadway. Roadway maintenance is the care taken and work performed to keep that part of the right-of-way on which the track is constructed in good condition. Right-of-way includes excavations, embankments, slopes, shoulders, ditches, and diversions of roads and streams. Maintenance is discussed in detail in TM 55-204.

b. Track. In a theater of operations, the track must be maintained in operable condition at all times. The four primary considerations in track maintenance are gage, surface, alignment, and dress. The roadbed and track must be inspected

frequently to avoid delays in operation resulting from damage caused by sabotage, direct enemy action, or weather.

c. Structures. In a theater of operations, the structures essential to the railway operation must be maintained in accordance with the standard maintenance prescribed. Structures include bridges, culverts, tunnels, and fueling and watering facilities. When repairing structures, minimum clearances must be observed at all times.

d. Distortion. The continual passing of trains around a curve eventually moves the track, which disturbs alinement and distorts the curve. The track should be restored to its correct curvature after determining if any distortion exists. This should be done by TRS maintenance-of-way personnel. A field expedient for determining the curvature of a track is the string method (para 4-45).

4-44. Degree of Curvature and Curve Radius

The table below shows relationships between degree of curvature and radius of curvature for simple curves. Degree of curvature means the degrees of central angle subtended by a 100-foot (30.48-meter) chord. Radius of curvature is the distance from the apex of the central angle out to the curve. The degree of curvature and radius of curvature form the sector of a circle; the area of this sector may be expressed in either of the following ways—

$$\begin{aligned} \text{Area} &= \frac{R \times \text{arc}}{2} \\ &= \frac{3.1416 \times R^2 \times D}{360} \end{aligned}$$

$$\begin{aligned} \text{Equating the two expressions} \\ \text{above, } R &= \frac{\text{arc} \times 360}{2 \times 3.1416 \times D} \\ &= \frac{\text{arc} \times 57.3}{D} \end{aligned}$$

Where

R = radius of curvature in feet

D = degree of curvature in degrees

For a 1° curve, the arc and chord are almost the same. Therefore, for practical purposes the arc in the formula for R above can be called a 100-foot chord for a C value

of 1°. R then equals 5,730 for a 1° curve, and $\frac{5,730}{D}$ for a D-degree curve.

D	R	D	R	D	R
1	5730	8	716	15	382
2	2865	9	637	16	358
3	1910	10	573	17	337

<i>D</i>	<i>R</i>	<i>D</i>	<i>R</i>	<i>D</i>	<i>R</i>
4	1433	11	521	18	818
5	1146	12	478		
6	955	13	441		
7	819	14	409		

4-45. Determining Curvature by String Method (Fig 4-19)

If a surveying instrument is not available, the degree of simple curvature (arc of a circle) of a track may be computed by the string method. Although this method is not exact because of the uncertainty of how much the string has stretched, the degree of error is insignificant. To determine the degree of curvature of a track by the string method—

a. Select a portion of track well within the main body of the curve.

b. Measure a chord distance of 62 feet (18.897 meters) along the inside (five-eighths of an inch down from the top) of the high rail (A to B, fig 4-19).

c. Stretch a string or strong cord very tightly between points A and B, and measure the distance M at the midpoint of the cord. The distance in inches is approximately equal to the degree of curvature. In the example shown in figure 4-19, if M is 5 inches, the degree of curvature is 5°. (As a curve gets sharper, the distance M increases.)

4-46. Railway Supply

a. Railway supplies, as distinguished from organizational supplies, are expendable supplies required for the operation and maintenance of railway divisions.

b. Whenever possible, local sources of supply should be used to ease transportation requirements. In a theater of operations, supplies may be procured from military stocks, manufacturers that are in or near the theater, foreign railways, captured enemy material and equipment, parts and assemblies manufactured or repaired by the railway battalion, and transfers from other railway operation units.

c. All operating units must submit reports of supplies on hand at the beginning of operations to facilitate supply control.

d. The battalion supply officer serves as fuel agent for the railway transportation battalion; he is responsible for the operating agencies of the transportation railway service receiving sufficient locomotive fuel—regardless of source. Requisi-

tions for fuel and lubricants are made through normal supply channels.

e. Tables of allowances and supplies are prepared by the supply officer of the highest transportation railway echelon for all units within the command. A workable stock level allowance must be determined for each unit to insure uninterrupted operation at all times. Normally, stock levels for the railway division are determined from past requirements.

f. An estimate of repair parts requirements may be made by using the factor of 1.5 short tons per month for each train per day moving in either direction. Beginning with the first railway division, select the train density established for the division, and multiply by 2 (for two-way travel); then multiply this result by 1.5, which equals the total amount in short tons of spare parts required per month for this specific division. Continue this process for each successive division to determine the grand total of short tons required per month for the entire railway. This is an estimate only. Revisions are necessary based on operation conditions.

4-47. Supply Request Procedure

a. The normal procedure for requesting a Transportation Corps item of supply is as follows. The company commander submits a request to the battalion supply officer. The battalion supply officer consolidates requests, makes lateral transfers of transportation supplies when necessary, prepares a formal request, and forwards it to the railway group supply officer. The supply officer of the railway group determines if the item or items requested are available in one of the other units assigned to the railway group. The item or items are transferred if they are available, if they are not available, the request is processed and forwarded to the Assistant Chief of Staff, Services and Maintenance, of the Transportation Railway Brigade. He may then direct the transfer of the requested item or items from one railway group to another. If the items cannot be obtained from another railway group, he passes the request to the transportation depot company for issue.

b. When the railway group is the highest echelon of the transportation railway service in the theater, the group supply officer discharges supply responsibilities. When the railway battalion is not operating as a part of a railway group, the battalion supply officer is authorized to handle supply matters directly with supply agencies. The highest transportation railway service headquarters in

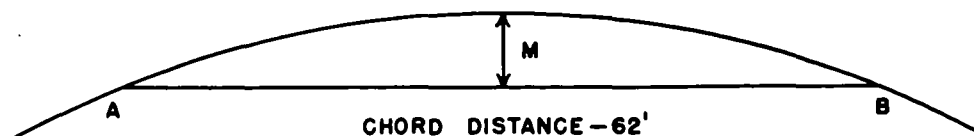


Figure 4-19. Determination of degree of curvature, using the string method.

the theater may authorize the battalion supply officer to request certain transportation items of routine supply directly from the appropriate supply depot without the approval of the next higher echelon. Items in short supply may be controlled as necessary, depending on the stock level in the depot. The battalion supply officer may be permitted, by the same headquarters, to request routine items from the depots of the other technical services.

c. To obtain supplies from outside sources—industry, railway, stocks, and railway supply channels—the battalion supply officer prepares purchase orders or requests in accordance with the policy established in the particular theater. Normally, purchase orders or requisitions are for-

warded to the railway group supply officer for further action; however, the railway battalion commander may be delegated the authority to approve purchase orders and requisitions for specified quantities of particular supplies. In such cases, the battalion procures the supplies locally and sends information copies of the transaction to the railway group supply officer. When the company commander is authorized to make local purchases, information copies of each transaction must be sent to the battalion supply officer. It is essential that accurate records be maintained of all transactions in order to protect the US Government from fraudulent claims.

d. All captured enemy material and equipment must be recorded and accounted for.

CHAPTER 5

TERMINAL AND WATER TRANSPORT

Section I. TERMINAL ORGANIZATION

5-1. Terminal Units: Capabilities and Assignments (Condensed)

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Headquarters and headquarters company, transportation terminal command A.	55-131	To command assigned and attached units engaged in the transfer of cargo and personnel in established terminal operations, logistics-over-the-shore (LOTS) operations, and in support of amphibious operations.	To a logistical command.	At full strength, this unit provides the organizational structure and a nucleus of a minimum number of trained transportation terminal operation and administrative personnel to command, plan, supervise, and coordinate within the limits imposed by distance, terrain, and dispersion criteria, the operations of the following: a. From two to three battalion headquarters with assigned and attached units. b. From five to ten separate companies or the equivalent in administrative and support requirements.
Headquarters and headquarters company, transportation terminal command B.	55-121 (Tentative)	a. To command assigned and attached units engaged in the transfer of cargo and personnel in established terminals, LOTS operations, and in the support of amphibious operations. b. When augmented by appropriate TD, the terminal command may also be designated as an area command.	To a theater of operations. Normally attached to a logistical command or other appropriate headquarters.	At full strength, this unit provides the organizational structure and personnel to command, plan, supervise, control, and coordinate the operations of from three to five terminal battalion headquarters with assigned and attached units and appropriate separate administrative and logistical support units as required.
Headquarters and headquarters company, transportation terminal command C.	55-111 (Tentative)	a. To command assigned and attached units engaged in the transfer of cargo and personnel in established terminal operations, LOTS	To a theater of operations. Normally attached to a logistical command or other appropriate headquarters.	At full strength, this unit provides the organizational structure and personnel to command, plan, supervise, control, and coordinate the operations of from 5 to 12 battalion

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
		operations, and in support of amphibious operations. b. When augmented by appropriate TD, the terminal command may also be designated as an area command.		headquarters with assigned and attached units and appropriate separate administrative and logistical support units as required.
Headquarters and headquarters detachment, transportation terminal battalion.	55-116	To provide command, administration, and supervision of assigned and attached transportation terminal type units engaged in: a. Operation of LOTS sites; b. Transfer of personnel and cargo from one mode of transportation to another at established water terminals; c. Operation of inland terminal transfer points; d. Support of Army and joint tactical operations.	To a field army, separate corps force, or logistical command. Normally attached to a transportation terminal command.	Commands and controls from three to eight (depending on conditions) transportation terminal service companies, transportation boat companies, transportation amphibian companies, transportation terminal transfer companies, transportation staging area companies, transportation truck companies, or any combination thereof.
Transportation terminal service company.	55-117	To load, unload, or transport from one to another means of transportation (water, rail, air, highway) at terminals and over-the-shore facilities.	To theater of operations. May be attached to transportation terminal command; headquarters and headquarters detachment, transportation terminal battalion, TOE 55-116; or may operate separately under the supervision of appropriate staff transportation officer.	At full strength, operating on a 24-hour basis at two locations at established terminals or over beaches, can provide the following capabilities: a. Discharge 1,200 short tons of general cargo or 1,800 tons of vehicles, or 1,350 short tons of mixed cargo per day. b. Load 600 short tons of general cargo or 1,800 tons of vehicles, or 675 short tons of mixed cargo per day. c. The following figures can be used for long-range planning: (1) Discharge on standard fire-hatch ship at the average rate of 720 short tons of general cargo daily or load one standard fire-hatch ship at

Transportation terminal
transfer company.

55-118

To transship cargo at
Army air, rail, motor,
and inland barge termi-
nals.

To a field army support
command, corps support
brigade, or a logistical
command. Normally as-
signed to a headquarters
and headquarters com-
pany, transportation bri-
gade, TOE 55-62. May be
attached to the motor
transport and/or aviation
groups as required. May
be assigned or attached
to a logistical command.

the average rate of 500 short tons of
general cargo daily.

(2) Sort cargo by technical serv-
ice and load the cargo on an initial
means of transportation at the pier
or at the waterline in a beach opera-
tion.

(3) Prepare transportation docu-
ments for all cargo handled by the
unit.

(4) Account for the cargo han-
dled.

a. At full strength, this unit is
capable of:

(1) Transshipping 900 short tons
of cargo daily.

(2) As required, redocumenting
transshipped cargo.

(3) Operating at three separate
terminals on an around-the-clock ba-
sis.

b. At reduced strength, this unit
is capable of:

(1) Transshipping 600 short tons
of cargo daily.

(2) As required, redocumenting
transshipped cargo.

(3) Operating at two separate
terminals on around-the-clock basis.

At full strength, this unit is capable
of:

a. Transporting an average of 720
short tons of general cargo based on
an average load of 30 short tons per
each of 12 landing craft making two
trips daily.

b. Transporting, in a one-time
maximum lift, 960 short tons of gen-
eral cargo based on 16 landing craft.

c. Transporting, in a one-time
maximum lift, 3,200 combat-equipped
troops based on 16 landing craft.

Transportation medium
boat company.

55-128

To provide and operate
landing craft for the
movement of personnel
terminal operations and
to augment, when re-
quired, naval craft in
joint amphibious opera-
tions.

To a logistical command or
other appropriate com-
mand in a theater of
operations. May be at-
tached to a transporta-
tion boat battalion
headquarters, a transpor-
tation terminal battalion
headquarters, or a trans-
portation terminal com-
mand headquarters. May
be attached in support of
joint amphibious opera-
tions or may operate
separately under appro-
priate staff transporta-
tion officer.

Unit	TOE	Mission	Assignment	Capability
Transportation heavy boat company. 55-129		To provide and operate landing craft for transporting personnel and heavy cargo in offshore discharge operations and for augmenting lighterage service in a port or harbor in inland or coastal waters, or on the open sea including lighterage service required in joint amphibious or other waterborne tactical operations.	To a communications zone, logistical command, or other appropriate command in a theater of operations. May be attached to a transportation terminal command headquarters, an engineer amphibious support command, or may operate separately under appropriate staff transportation officer.	a. Transports an average of 16,000 troops with individual equipment, 2,160 short tons of vehicles, or 6,000 short tons of tanks, based on 10 landing craft making four trips daily. b. Transports an average of 1,440 short tons of general cargo based on 10 landing craft making one trip daily. c. Transports, in a one-time maximum lift, 1,800 short tons of cargo or 4,080 troops with individual equipment, based on use of 12 landing craft. d. Maximum load, per vessel: 150 short tons of cargo or 400 troops with individual equipment for a trip not exceeding 2 hours, 350 troops for trips of from 2 to 3 hours, and not more than 300 troops for trips of over 3 hours. e. Range of 1,200 nautical miles at 7 knots. f. Using tug, tows disabled craft, retrieves beached craft, or augments the lift of the company when barges are available. At full strength, this unit has the following capabilities: a. Operating two 10-hour shifts, transports daily an average of 1,080 short tons of general cargo, assuming availability of 27 lighters, each lighter carrying 4.5 tons per trip and averaging approximately nine trips per day. b. Operating two 10-hour shifts, transports daily approximately 7,800 combat-equipped troops, based on an availability of 27 lighters, each making 12 round trips with an average load of 25 men. c. Transporting in a one-time lift, 170 short tons of general cargo, based
Transportation light amphibian company. 55-138		To provide lighterage for movement of cargo and personnel between ship and shore, or from shore to shore, in an amphibious or logistical operation.	Assigned to a logistical command. May be attached to a transportation terminal command, a transportation terminal battalion, or may operate separately under the supervision of the appropriate staff transportation officer.	

Transportation medium
amphibian company.

55-139

To provide lighterage for the movement of cargo and personnel from ships lying offshore to transfer/segregation points beyond the beach line in LOTS operations and in support of amphibious operations.

Assigned to a logistical command. May be attached to a transportation terminal command, a transportation terminal battalion, or may operate separately under the appropriate staff transportation officer.

on 34 lighters carrying 5 tons each or 816 combat-equipped troops based on 34 lighters carrying 24 men each.

At full strength, this unit is capable of the following:

a. Transporting daily, operating two 10-hour shifts, an average of 1,080 short tons of general cargo per day assuming availability of 19 lighters, each lighter carrying approximately 10.2 tons per trip and averaging five to six trips per day.

b. Transporting daily, operating two 10-hour shifts, 9,500 combat-equipped troops, based on an availability of 19 lighters, each making 10 round trips with an average load of 50 men.

c. Transporting a maximum one-time lift of 360 short tons of general cargo, based on 24 LARCs carrying 15 short tons each or 1,200 combat-equipped troops, based on 24 LARCs carrying 50 men each. At reduced strength, operating only one 10-hour shift and with 19 lighters operational, this unit can transport approximately 540 short tons or 4,050 combat-equipped troops daily. The reduced strength column adapts this table of organization and equipment to the lesser requirements for personnel and equipment during prolonged noncombat periods and for a limited period of combat.

Transportation heavy am-
phibian company.

55-140

To provide lighterage for movement of personnel, wheeled and tracked vehicles, and general cargo from ships lying offshore to transfer/segregation areas beyond the beach line in LOTS operations and in support of amphibious operations.

Assigned to a logistical command. May be attached to a transportation terminal command, transportation terminal battalion, or may operate separately under the supervision of the appropriate staff transportation officer.

At full strength, this unit is capable of:

a. Transporting daily, operating two 10-hour shifts, an average of 1,800 short tons of cargo (vehicles and other heavy or outsized equipment) or 7,200 combat-equipped troops, based on 12 lighters making five round trips with an average load of 30 tons or 120 men.

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Transportation floating craft depot maintenance company.	55-157	To provide depot maintenance for Army floating craft including landing craft of transportation boat companies.	To a transportation floating craft maintenance battalion or to a transportation terminal command.	b. Transporting in a maximum one-time lift, with 15 lighters available, 900 short tons (60 tons per LARC-LX) of general cargo or 3,000 (200 troops per LARC-LX) combat-equipped troops. The reduced strength column adapts this table of organization and equipment to the lesser requirements for personnel consistent with operating only one 10-hour shift and with 12 lighters operational, transports an average of 900 short tons of cargo (vehicles and other heavy or outsized equipment) or 3,600 personnel daily. a. Provides depot maintenance on a 24-hour basis for approximately 100 self-propelled craft (70 on a one-shift basis at reduced strength), plus all nonpropelled craft associated therewith. b. In order to accomplish its mission, a drydock and/or barge crane must be provided for use by this unit. If these items of equipment are not available locally, they must be furnished with crews from appropriate teams from TOE 55-500R.
Transportation amphibian general support company.	55-158 (Tentative)	a. To provide general support maintenance (third and fourth echelon) for amphibians in a theater of operations. b. To receive, store, and issue all items of supply required for maintenance support of amphibians within its maintenance capability.	To logistical command. May be attached to transportation terminal command; headquarters and headquarters detachment, transportation terminal battalion, TOE 55-116D; or may operate separately under the supervision of appropriate staff transportation officer.	a. Provides direct support and general support maintenance for 1,000 amphibian equivalents (3.8 equivalents for the LARC-V, 6 for LARC-XV, and 10 for the LARC-LX). b. Receives, stores, and issues all items of supply required for maintenance support of 1,000 amphibian equivalents. c. Repairs unserviceable assemblies and returns them to supply channels. d. Provides technical assistance service to supported units when required. e. Provides direct support and general support maintenance for rolling

liquid transporters when augmented by teams from TOE 29-500D.

Transportation service organization. 55-500
(Tentative)

To provide personnel and equipment for the following purposes:

a. To supplement Transportation Corps TOE units where additional trained personnel are required in numbers less than TOE organization strength.

b. To perform Transportation Corps functions as part of a larger organization where the need for such activity is less than a similar TOE unit.

c. To form an organization where no TOE unit is provided or where a number of small cells of diversely trained personnel are required for the proper functioning of an organization.

Teams may be attached or assigned as required to higher echelon units or may be organized into service units to perform the functions required by existing conditions.

Transportation special services organization. 55-510
(Tentative)

To perform transportation specialized service functions to increase the productive capacity of fixed-site units where increments of less than company size are needed.

Teams will be attached or assigned as required to fixed-strength units or may be organized along with teams from TOE 55-500.

a. As indicated in detailed breakdown of teams, and

b. These detachments are not self-sufficient but will be attached to, or dependent on, other units, as indicated, for individual teams for administration, mess, supply, and/or motor maintenance.

5-2. Assigned or Attached Units

Terminal commands may have any combination of these units assigned or attached as required to perform their mission.

<i>TOE</i>	<i>Unit</i>
55-16	Headquarters and Headquarters Detachment, Transportation Motor Transport Battalion.
55-17G	Transportation Light Truck Company.
55-18G	Transportation Medium Truck Company.
55-19	Transportation Car Company
55-28G	Transportation Heavy Truck Company.
55-116	Headquarters and Headquarters Detachment, Transportation Terminal Battalion.
55-117	Transportation Terminal Service Company.
55-118	Transportation Terminal Transfer Company.
55-128	Transportation Medium Boat Company.
55-129	Transportation Heavy Boat Company.
55-138	Transportation Light Amphibian Company.
55-139	Transportation Medium Amphibian Company.
55-140	Transportation Heavy Amphibian Company.

55-157	Transportation Floating Craft Depot Maintenance Company.
55-158	Transportation Amphibian General Support Company.
55-500 (Tentative)	Transportation Service Organization.
55-510	Transportation Special Services Organization.

b. Other Units.

<i>TOE</i>	<i>Unit</i>
5-129.	Engineer Company, Port Construction.
5-500	Engineer Service Organization.
8-500	Medical Service Organization.
9-500	Ordnance Service Organization.
10-500	Quartermaster Service Organization.
11-500	Signal Service Organization.
12-605	Army Postal Unit, General Assignment.
14-500	Finance Service Organization.
19-55	Military Police Battalion.
19-57	Military Police Company.



Section II. VESSEL AND AMPHIBIAN

5-3. Transportation Floating Craft

Nomenclature	Designation	Classification	Length (overall)	Beam (molded)	Maximum draft	Displacement (LTON)		Capacity (gal.)		
						Light	Loaded	Water		Fuel
Vessel, liquid cargo, diesel, steel, 6,500 bbl, 182', design 294A.	Y	STD-B	182'6"	30'0"	11'2 1/4"	476	1,458	3,000	10,480	9,980
Vessel, supply, diesel, steel 176' design 381.	FS	STD-B	176'6"	32'0"	10'0"	465	935	2,042	11,624	21,000
Vessel, special purpose, diesel, steel, 179', design 427.	FS	STD-B	179'10"	32'5"	11'3"	684.77	899	1,502	14,449	33,992
Vessel, dry cargo, diesel, steel, 1,000 ton, 210', design 7013.	FS	STD-B	222'9 3/4"	38'0"	14'6"	892	2,150	10,000	15,940	54,100
Vessel, liquid cargo, diesel, steel, 11,500 bbl, 210', design 7014 (fig. 5.1).	Y	STD-A	222'9 3/4"	38'0"	17'0"	797	2,500	10,000	15,940	58,670
Vessel, refrigerator, diesel, steel, 54,102 cu ft capacity, 210', design 7015.	FSR	STD-B	222'9 3/4"	38'0"	15'0"	975	2,388	10,000	15,940	62,000

5-4. Boats

Nomenclature	Designation	Classification	Length (overall)	Beam (molded)	Depth molded amidships	Displacement (LTON)	
						Light	Loaded
Boat, utility, diesel, plastic 26'6", design 6009.	J	STD-B	26'6"	8'1"	4'9 7/8"	3.04	4.02
Boat, picket, diesel, wood, 36'6", design 243-B.	J	STD-B	36'6"	10'7"	5'10"	6.7	---
Boat, picket, diesel, steel, 46'4 1/2", design 4003 (fig. 5-2).	J	STD-A	46'4 1/2"	12'3"	6'3 7/8"	10	12
Boat, picket, diesel, wood, 64'11", design 4002 (fig. 5-3).	Q	STD-A	64'11"	15'11"	8'3"	31	34.5
Boat, passenger and cargo, diesel, steel, 65'6", design 2001 (fig. 5-4).	T	STD-A	65'6 3/4"	17'8"	8'9 7/8"	66	95

CHARACTERISTICS AND DATA

Speed (knots)	Range (nautical miles)	Cargo capacity			Cargo space		Lift capacity (LTON)		Remarks
		Dry (cu ft)	Refrig (cu ft)	Liquid (42-gal. bbl)	Hatches	Tanks	Std	Heavy	
8	2,560	2,400	-----	6,711.3	1	6	-----	-----	1 Dry cargo hatch 2,400 cu ft 6 Liquid cargo tanks.
12	4,500	21,462	-----	-----	2	0	5	15	
12	5,320	-----	-----	-----	1	0	5	10	Designed as an aircraft repair vessel and <i>not</i> as a cargo carrier. Hatch size 6' x 16'.
13.37	6,750	56,400 plus 3,400 special	-----	-----	3	0	5	-----	Equipped with two level luffing cranes.
12.7	7,700	3,382 special	-----	11,079.8	1	9	2,000	-----	1 Dry cargo hatch 3,382 cu ft. 9 Liquid cargo tanks. Equipped with two 800 gpm cargo pumps.
12	7,500	-----	40,920	-----	3	0	5	-----	

Maximum draft (aft)	Fuel capacity (gal.)	Fuel con- sumption (gals. per hour)	Fresh water (gal.)	Speed (knots)	Cruising range (nautical miles)	Capacity		Remarks
						Cargo (LTON)	Passenger	
3'6"	80	4	---	10	200	1	12-15	Transported on cradle.
3'3"	300	11.38	---	15	355	---	6-8	(1) Transported on cradle. (2) Bow reinforced for beaching.
2'9"	370	19	50	14	245	1.33	25	(1) Transported on cradle. (2) Replaces 243-B.
5'10"	900	24.2	400	14	468	4	5	Transported on cradle.
6'6"	1,150	18	400	7	397	24	24	(1) Normally deckloaded. (2) Limited ocean sailing under good conditions.

5-5. Tugs

<i>Nomenclature</i>	<i>Designation</i>	<i>Classification</i>	<i>Length (overall)</i>	<i>Beam (molded)</i>	<i>Depth molded amidships</i>	<i>Displacement (LTON)</i>		<i>Maximum draft (aft)</i>
						<i>Light</i>	<i>Loaded</i>	
Tug, harbor, diesel, 200 HP, steel, 45', design 320.	ST	STD-A	45'2¼"	12'9¾"	7'9¾"	25	29	6'
Tug, harbor, diesel, 600 HP, steel, 65', design 3004.	ST	STD-A	70'11½"	19'6"	9'7¾"	100	122	8'2¾"
Tug, harbor, diesel, 650 HP, steel, 85', design 327-DS.	ST	STD-B	86'5"	23'0"	10'4"	156	223	8'6"
Tug, harbor, diesel, 1,200 HP, steel, 100', design 3006.	LT	STD-A	107'0"	26'6"	14'10"	295	390	12'2"
Tug, oceangoing, diesel- electric, 1,530 HP, steel, 143', design 377A.	LT	STD-B	143'5"	33'0"	17'4"	566	807	14'

*Range are estimated as free running.

<i>Fuel capacity (gal.)</i>	<i>Fuel rate (gal. per hour)</i>	<i>Fresh water (gal.)</i>		<i>Speed (knots)</i>	<i>Range * (nautical miles)</i>	<i>Bollard pull (pounds)</i>	<i>Remarks</i>
<i>Potable</i>	<i>Nonpotable</i>						
900	10.25	55	----	10	790	4,400	Deckloaded for overseas shipment.
5,844	36.1	900	----	12	1,700 light (142 hours w/tow)	17,500	Normally transported overseas on a larger vessel.
11,252	37.5	500	4,100	9.5	2,686	-----	(1) Normally transported overseas on a larger vessel. (2) Tow rope pull:
						<i>Knots</i>	<i>Pounds</i>
						0.0 -----	14,900
						4.0 -----	13,100
						7.0 -----	11,000
21,146	68	2,756	----	12	3,700 (294 hours w/tow)	27,500	Ocean sailing capability.
58,131	130	400	6,810	11.5	5,100	-----	(1) Ocean sailing capability. (2) Tow rope pull:
						<i>Knots</i>	<i>Pounds</i>
						0.0 -----	42,000
						4.0 -----	38,000
						5.0 -----	36,300
						6.0 -----	34,100
						7.0 -----	33,000

5-6. Floating Cranes

Nomenclature	Designation	Classification	Length (overall)	Beam (molded)	Depth (molded)	Displacement (LTON)		Draft		Capacity (gal.)		Cargo handling equipment capacity	Remarks
						Light	Loaded	Light	Loaded	Fuel	Fresh water		
Crane, barge, diesel-electric, revolving, steel, 60 LTON, de- sign 413-D (fig. 5-5).	BD	STD-A	142'0"	58'0"	12'0"	1,132	1,192	5'1"	5'6"	1,350	600	Main hoist: 60 LTON @ 73' radius Aux hoist: 15 LTON @ 100' radius Main hoist reach below surface: 50'	(1) Can be towed overseas. (2) Boom length: 95'6".
Crane, barge, diesel-electric, revolving, steel, 89 LTON, de- Sign 264-B (fig. 5-6).	BD	STD-A	140'0"	70'0"	12'6"	1,407	1,497	5'7"	5'11"	15,000	30,200	Main hoist: 75 LTON @ 104'6" radius; 89 LTON @ 80' radius Aux hoist: 15 LTON @ 122'6" radius Aux hoist reach below water- line: 25'.	(1) Can be towed overseas. (2) Boom length: 123'6".

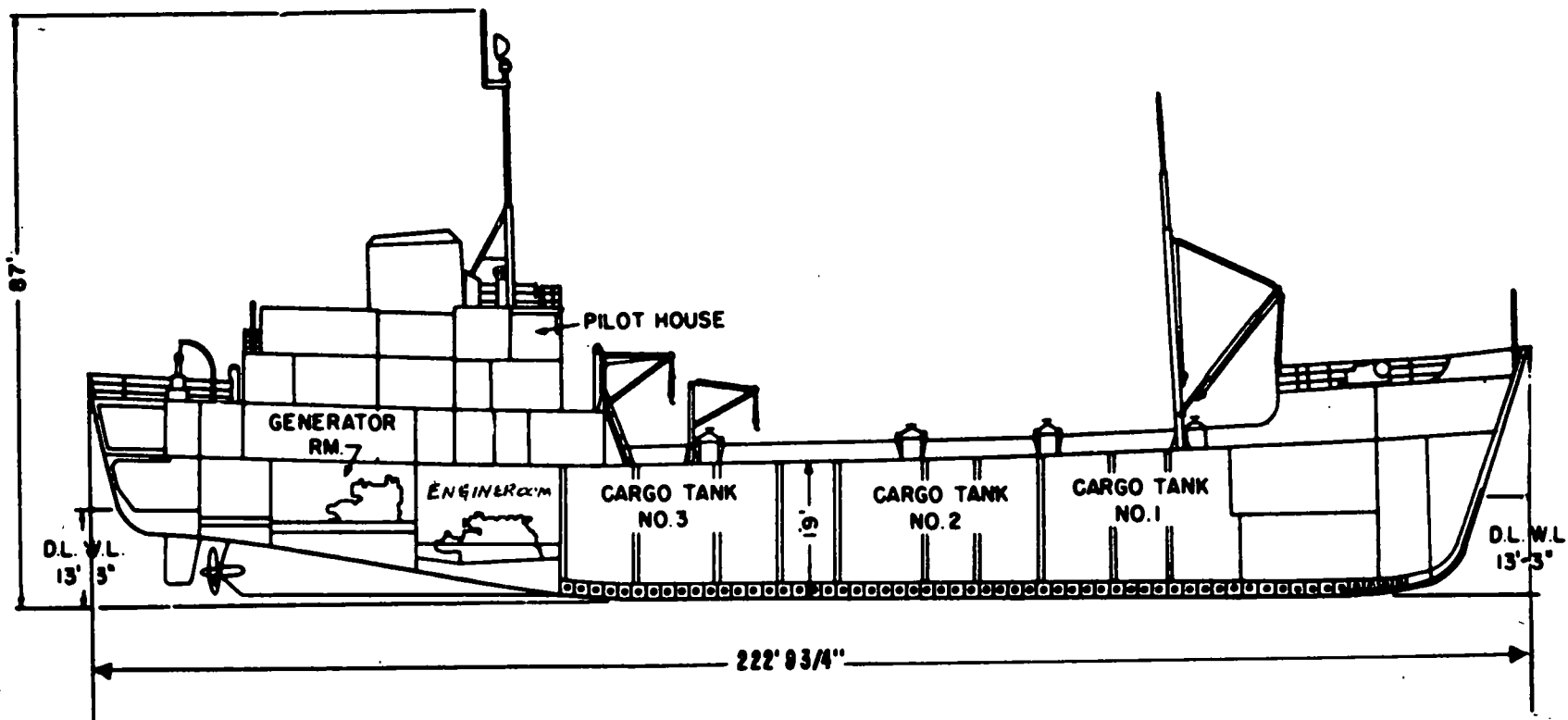


Figure 5-1. Vessel, liquid cargo, diesel, steel, 11,500 barrels, 210 feet, design 7014.

5-7. Barges

Nomenclature	Designation	Classification	Length (overall)	Beam (molded)	Depth (molded)	Displacement (LTON)		Maximum draft		Liquid	Cargo		Remarks
						Light	Loaded	Light	Loaded		Dry		
Barge, deck cargo, nonpropelled, steel, 475 tons, 110', design 299.	BC	STD-B	110'	30'	7'4"	116.8	591.8	1'5"	7'	----	475	LTON	(1) Deck bin size: 78' x 24' x 5' with loading gates on four sides. (2) Can be towed overseas.
Barge, deck cargo nonpropelled, steel, 570 tons, 110', design 7005 (fig. 5-7).	BC	STD-A	110'	32'	9'0"	120	690	1'8"	7'8"	----	570	LTON	(1) Conversion kit, barge deck enclosure, design 7006, is adaptable to this item. (2) Can be towed overseas.
Barge, deck cargo, nonpropelled, steel, 585 tons, 120', design 231A (fig. 5-8).	BC	STD-A	120'	33'	10'6"	175	760	2'4"	8'0"	----	585	LTON	(1) Can be towed overseas. (2) Hull designed for relatively high-speed towing.
Barge, deck or liquid cargo, nonpropelled, steel, 578 tons or 4,160 bbl, 120', design 231B (fig. 5-9).	BG	STD-A	120'	33'	10'6"	175	753	2'4"	8'6"	4,160 bbl	578	LTON on deck	Can be towed overseas with full load, provided maximum draft does not exceed 8'.
Barge, refrigerator, nonpropelled, steel, 14,200 cu ft, 120', design 7010.	BR	STD-B	120'	33'	10'6"	225	546	3'0"	5'10"	----	14,200	cu ft	Can be towed overseas.
Repair shop, floating, marine equipment nonpropelled, steel, 210', design 7011.	FMS	STD-A	210'5"	40'	15'0"	1,160	1,525	6'1"	7'9"	N/A	N/A		(1) Can be towed overseas. (2) Repair shops include electrical, carpentry, engine repair, battery, fuel injection, blacksmith, machine, refrigeration, sheet metal, welding, pipe fitting, paint, and ship fitting.
Barge, deck or liquid cargo, nonpropelled, steel, 21 tons or	BK	STD-B	45'	18'	3'0"	13	33	8"	1'8"	225 bbl	20.98	LTON on deck	(1) Can be sectionalized for deckloading and rail movement. (2) Transports limited quan-

225 bbl, 45',
knockdown, de-
sign 218E.

titles of liquid or dry
cargo on inland waters.

- (3) Barge is divided into two
sections, each 9'2" x
45'5" x 3'0".

Barge, deck cargo, nonpropelled, steel, 130 tons, 81', section- alized, nesting, design 7001 (fig. 5-10).	BK	STD-A	81'	22'	7'0"	57.5	203	1'6"	4'9"	----	Deck 130 LTON (hold 105 LTON dry)	(1) Can be sectionalized and nested for shipment. (2) Lacks stability.
Pier, barge type, self-elevating, nonpropelled, steel, 250' long, 60' wide, 10' deep, design 7024.	BPL	STD-A	250'	60'	10'2"	1,482.4	1,844.4	---	4'5"	----	362 LTON	(1) Can be towed overseas. (2) Used to construct piers and sea island termi- nals. Fitted with one compressor for air jacks, 12 each 100' x 6' caissons.
Pier, barge type, self-elevating, nonpropelled, steel, 427' long, 90' wide, 15' deep, design 7025.	BPL	STD-A	427'	90'	15'3"	4,618.3	5,339.5	---	5'	----	721.2 LTON	(1) Can be towed overseas. (2) Same as design 7024. Fitted with three com- pressors for air jacks, 38 each 100' x 6' cais- sons.

5-8. Landing Ships

<i>Nomenclature</i>	<i>Designation</i>	<i>Length (overall)</i>	<i>Beam (overall)</i>	<i>Light displacement (LTON)</i>	<i>Draft loaded</i>		<i>Speed (knots)</i>	<i>Operating range (nautical miles)</i>
					<i>Forward</i>	<i>Aft</i>		
Dock, landing ship, LSD-1 class (U.S. Navy). ³	LSD	457'9"	72'1¾"	4,428	18' dry; 30'4¾" flooded.	18' dry; 30'4¾" flooded.	15	10,000
Dock, landing ship, LSD-28 class (U.S. Navy).	LSD	510'1½"	84'2"	6,143	19' dry; 32' 6" flooded.	19' dry; 34'1" flooded.	16.5	9,500
Tank, landing ship, LST-542 class (U.S. Navy).	LST	328'	50'	1,589	Normal beaching 4'4"; maximum beaching 5'3"; full load cannot beach 7'2"	Normal beaching 9'3"; maximum beaching 10'2"; full load cannot beach 13'0".	8.5	17,800
Tank, landing ship, LST-1153 class (U.S. Navy).	LST	382'	54'	2,009	Normal beaching 3'4"; maximum beaching 3'11"; full load cannot beach 9'6".	Normal beaching 11'3"; maximum beaching 11'11"; full load cannot beach 16'3".	10.4	7,706
Tank, landing ship, LST-1156 class (U.S. Navy).	LST	384'	55'7"	2,635	Normal beaching 4.2"; maximum beaching 4'11"; full load cannot beach 8'3".	Normal beaching 9'11"; maximum beaching 10'8"; full load cannot beach 14'8".	12	6,000
Tank, landing ship, LST-1171 class (U.S. Navy).	LST	442'	62'1"	4,150	Normal beaching 4'0"; maximum beaching 5'8"; full load cannot beach 9'9".	Normal beaching 13'0"; maximum beaching 13'11"; full load cannot beach 16'0".	14	6,048
Lighter, beach discharge, deck cargo, diesel, steel, 338 ft, design 5002 (U.S. Army) (fig. 5-11).	BDL	338'	65'	1,548.8	Beaching 4'0"; ocean 7'8".	Beaching 10'0"; ocean 13'8".	8.5	5,500

¹ Characteristics of U.S. Navy ships vary within each class. Exact data, detailed hold dimensions, and cargo carrying capacities will be found in individual "Ship's Loading Characteristics Pamphlets."

² The LSD is not a true landing ship in that it does not have beaching capabilities.

Capacities			Cargo planning ¹						Remarks
Cargo (LTON)	Troops		Deck	Deck dimensions		Area in sq ft	Weight limit		
	OFF.	EM		Length	Width		Per sq ft (lb)	Total (STON)	
1,233 combat.	16	250	Well; half; super.	394'; 125'; 141'6"	42'10"; 42'; 44'10"	16,776; 5,250; 6,353	----- 86 lb 100 lb	----- 200 275	Maximum water depth on well deck: 10' fwd; 10' aft.
2,400 combat.	25	322	Well; mezza' nine; cargo; heli- copter.	396'; 144'; 71'2"; 71'	48'9"; 48'7" to 30'; 48'6"; 43'5"	18,400' 6,500; 3,143; 3,100	1,075 lb; 150 lb; 150 lb;	9,390 475 232	Maximum water depth on well deck: 10' fwd; 10' aft.
Normal beaching 500; maximum beaching 900; full load 1,358.	10	127	Tank Main	222'6" 100'0"	24'0" 45'0"	4,556 4,432	----- 300 lb	----- 400	Bow ramp— Capacity: 100 T (sup- ported). Capacity: 50 T (unsup- ported). Inside width: 12'6". Overhead clearance: 13'9".
Normal beaching 500; maximum beaching 900; full load 2,200.	17	180	Tank Main	280' 160'	30'5" 46'	8,972 6,268	----- -----	----- 1,000	Bow ramp— Capacity: 100 T (sup- ported). Capacity: 50 T (unsup- ported). Inside width: 14'2". Width between bulk- heads: 16'5". Overhead clearance: 16'6".
Normal beaching 500; maximum beaching 900; full load 1,563.	15	380	Tank Main	275'9" 187'	32'9" 47'8"	7,500 6,400	----- 550 lb	----- 1,000	Bow ramp— Capacity: 75 T (sup- ported). Capacity: 50 T (unsup- ported). Inside width: 14'2" Width between bulk- heads: 16'5". Overhead clearance: 17'0".
Normal beaching 500; maximum beaching 900; full load 2,400.	30	585	Tank Main	320' 208'	30' 60'	9,800 7,686	----- 500 lb	----- 1,000	Bow ramp— Capacity: 75 T (sup- ported). Inside width: 15'5 7/8". Width between bulk- heads: 17'. Overhead clearance: 17'3".
Beaching 600; ocean 2,200.	Total of 200 w/o berths	Cargo	-----	-----		15,000	800 lb	672	Bow ramp— Capacity: 60 STON. Width: 22'0". Overhead clearance: 13'6".

5-9. Landing Craft

Nomenclature	Designation	Classification (U.S. Army)	Length (overall)	Beam (molded)	Depth amidships	Light displacement (LTON)	Draft	
							Fwd	Aft
Landing craft, utility, diesel, steel, 115', Navy design <u>LCU 501</u> class.	LCU	STD-B	119'	32'	5'6"	143	Loaded 3'4"	Loaded 4'0"
Landing craft, utility, diesel, steel, 115', Navy design <u>LCU 1466</u> class (fig. 5-12).	LCU	STD-A	115'1"	34'	6'0"	180	Light 2'0"; loaded 3'1"	Light 3'10"; loaded 4'
Landing craft, utility, diesel, steel, 135', Navy design <u>LCU 1610</u> class.	LCU	-----	135'3"	29'	(^a)	165.1	Loaded 3'6"	Loaded 6'0"
Landing craft, mechanized, diesel, steel, 56', MARK VI, Navy design <u>LCM (6)</u> (fig. 5-13).	LCM	STD-B	56'	14'1"	5'9 5/8"	28	Loaded 3'0"	Loaded 4'8"
Landing craft, mechanized, diesel, steel, 69', MARK VIII, Navy design <u>LCM (8)</u> (fig. 5-14).	LCM	STD-A	73'8"	21'	9'5"	57.8	Light 3'0"; loaded 3'0"	Light 3'6"; loaded 5'0"
Landing craft, vehicle, personnel (<u>LCVP</u>).	^{LCVP} LCVP	-----	35'9"	10'11"	-----	8.48	2'0"	3'0"

^a Information not available.^b May vary because of propulsion design.^c Combat equipped.^d Safety factors permitting.

Fuel capacity (gal.)	Fuel consumption (gal. per hr)	Speed loaded (knots)	Operating range (nautical miles)	Capacity		Cargo space dimensions			Remarks
				Cargo (LTON)	Troop	Length	Width See remarks	Ramp opening	
3,450	34	6.5	700	161	300	101'0"		12'6"	(1) Fresh water capacity: 1,730 gallons. (2) Cargo space width—Bow to frame 10: 12½' to 26'. - Frame 10 to frame 28: 26'. Frame 28 to stern: 26' to 14'.
3,700	34	7	700	150	300	52'; 22'	29'6"; 14'4"	14'4"	Fresh water capacity: 9,563 gallons.
(*)	(*)	^b 9	^b 1,200	170	(*)	(*)	(*)	14'0"	Fresh water capacity not available.
450	26	8	124	32	^c 80 ^d 120	37'6"	11'0"	11'0"	
1,146	34	9	303	53.5	^c 200	42'9"	14'6"	14'6"	
200	13	7	102	3.6	^c 36	17'3"	7'5"	7'5"	

5-10. Amphibians

Nomenclature	Designation	Classification	Length (overall)	Beam (overall)	Height (overall)	Light displacement (LTON)	Draft	
							Fwd	Aft
Landing vehicle, wheeled, 2½-ton, 6 x 6, GMC model DUKW 353.	DUKW	STD-C	31'0"	8'2"	8'10"	6.4	^b Loaded 3'6"	^b Loaded 4'3"
Lighter, amphibious (LARC-V), self-propelled, diesel, aluminum, 5-ton, design 8005 (fig. 5-15).	LARC	STD-A	35'0"	10'0"	10'2"	8.48	^b Light 3'3"; loaded 4'1"	^b Light 3'9"; loaded 4'3"
Lighter, amphibious (LARC-XV), self-propelled, diesel, aluminum 15-ton design 8004.	LARC	STD-A	45'0"	14'7"	15'6"	20.81	^b Light 4'0"; loaded 4'11"	^b Light 4'11"; loaded 5'6"
Lighter, amphibious (LARC-LX), self-propelled, diesel, steel, 60-ton, 61 ft, design 2308 (fig. 5-16).	LARC *	STD-A	62'6"	26'7"	19'5"	87	^b Light 6'2"; loaded 7'11"	^b Light 7'5"; loaded 8'8"
Landing vehicle, tracked, personnel, model 5 (LVTP5A1) ^c	LVTP(5)	----	29'8"	11'8½"	10'½"	31.2	----	----
Landing vehicle, tracked, engineer, model 1 (LVTE1) ^d	LVTE1	----	39'9¼"	12'8 7/16"	10'8½"	36.9	----	----
Landing vehicle, tracked, recovery, model 1 (LVTR1A1) ^e	LVTR1	----	31'9"	11'8½"	17'6"	33.5	----	----
Landing vehicle, tracked howitzer, model 6 (LVTH6A1) ^f	LVTH6	----	29'8"	11'8½"	13'4½"	33.2	----	----

^a Without ring mount, reducible to 7'6".

^b Draft calculated from tire bottoms.

^c Emergency.

^d Reducible to 13'8".

^e Formerly BARC.

^f Reducible to 15'4".

^g Armored amphibian assault personnel and cargo carrier.

^h Reducible to 8'7½".

ⁱ Armored amphibian assault engineer vehicle.

^j Blade wings folded.

^k Armored amphibian recovery and maintenance vehicle.

^l Reducible to 10'9".

^m Armored amphibian assault vehicle.

ⁿ Reducible to 10'5½".

Fuel capacity (gal.)	Fuel consumption (gal. per hr)	Speed		Range		Capacity		Cargo space		Ramp opening
		Land (MPH)	Water	Land (statute miles)	Water (nautical miles)	Cargo (STON)	Troop	Length	Width	
40	8	50	5.5 knots	250	30	Norm 2.5; emerg 5	25	12'5"	6'10"	NA
144	17	30	8.6 knots	200	40	5	20	16'0"	9'9"	NA
360	Land 16.32, water 28.16	29.5	8.6 knots	300	54	15	50	24'0"	13'6"	9'0"
600	38	14	7 knots	150	75	Norm 60; emerg 100	Norm 125; emerg 200	38'3"	13'8"	14'6"
456	Land 48, water 47	20	6 mph	190	57	Water 6; land 9	34	11'5"; height 5'5"	7'3" height 5'5"	Width 7'3½" height (side) 4'2½" height (center) 4'6¼"
560	Land 35, water 53.3	24.9	6.2 mph	398	65	None	None	None	None	----
456	Land 48, water 47	20	6 mph	190	57	None	None	None	None	----
456	Land 48, water 47	20	6 mph	190	57	None	None	None	None	----

5-11. Navy Transport Vessels ^a

Nomenclature	Designation	Class	Type	Length (overall)	Beam	Displacement (LTON)		Draft	
						Light	Loaded	Light	Loaded
Amphibious force flag-ship.	AGC	Mount McKinley	C2-S-AI	459'6"	63'	5,450	15,295	15'	24'
Attack transport	APA	Haskell	VC2-S-AP5	455'3"	62'2"	6,720	12,450	14'	28'6"
Attack transport	APA	Bayfield	C3-S-A2	491'7½"	69'6"	8,100	16,100	15'6"	26'6"
Attack transport	APA	Paul Revere	C4-S-1	563'6"	76'	10,709	18,000	20'	27'
Attack cargo ship	AKA	Tulare	C4-S-1B	563'6"	76'	9,050	17,500	24'	28'
Attack cargo ship	AKA	Andromeda	C2-S-B1	459'3"	62'1½"	7,430	12,800	16'	28'
Attack cargo ship	AKA	Rankin	C2-S-AJ3	459'1"	63'	6,456	14,160	16'	27'7"
Transport	AP	Geiger	P2-S1-DN3	533'7"	73'2"	17,600	19,600	....	27'1"
Transport	AP	General	P2-S2-R2	622'6"	75'6"	11,828	20,175	....	25'6"
Transport	AP	General (Ex Admiral)	P2-SE2-R1	608'11"	76'5"	9,676	22,574	....	29'2"
Transport	AP	General	C4-S-A1	522'10"	71'8"	10,034	16,750	....	26'6"
High speed transport ...	APD	.....	EX-DE	306'	37'	1,400	2,130	....	13'
Transport submarine ..	APSS	Sea Lion	EX BALAD	311'6"	27'	1,590	1,900	....	17'
Landing ship vehicle ...	LSV	Comet	C3-ST-14A	499'	78'	7,605	18,150	17'	27'
Landing ship vehicle ...	LSV	Sealift	C4-ST-67A	540'	83'	11,130	21,700	....	29'

^a All data for planning purposes only. For exact data, see the individual ship's characteristics pamphlet.

^b Cargo space in square feet is for vehicle planning.

^c Maximum sustained speed and range.

^d Varies with vessel.

Speed (knots)	Cruising range (nautical miles)	Cargo (LTON)	Cargo space ^b	Capacity		Boom (LTON)	Troops	Remarks
				Craft				
15.5	21,000	----	12,360 cu ft	3 ea—LCVP 3 ea—LCPL		4 ea—10	474 (approx)	Equipped with helicopter platform.
18.0	20,500	446— 714	13,788 sq ft 123,198 cu ft	2 ea—LCM (6) 22 ea—LCVP 1 ea—LCPL 1 ea—LCPR		1 ea—35 8 ea—10 6 ea— 5	1,565	
17.2	11,630	446— 714	15,892 sq ft 154,238 cu ft	4 ea—LCM (6) 18 ea—LCVP 3 ea—LCPL 2 ea—LCPR		2 ea—30 6 ea—10	1,647	Equipped with helicopter platform.
20	12,000	1,500	10,487 sq ft 138,974 cu ft	1 ea—hel 7 ea—LCM (6) 12 ea—LCVP 2 ea—LCPL		2 ea—60 1 ea—30 3 ea—10 2 ea— 8 2 ea— 5	1,600	
20	12,000	4,375	33,363 sq ft 330,984 cu ft	9 ea—LCM (6) 15 ea—LCVP 3 ea—LCPL		2 ea— 5 6 ea—10 1 ea—40 3 ea—60	321	Equipped with helicopter platform.
16	14,280	1,335— 1,600	40,949 sq ft 299,797 cu ft	2 ea—LCM (3) 6 ea—LCM (6) 14 ea—LCVP 2 ea—LCPL		10 ea— 5 4 ea—10 2 ea—30	86— 326	
15	16,200	----	27,304 sq ft 316,823 cu ft	7 ea—LCM (6) 1 ea—LCM (3) 14 ea—LCVP 1 ea—LCPR 1 ea—LCPL		4 ea— 5 2 ea—10 4 ea—35	66— 126	
20	18,752	2,351	-----	-----		8 ea—10	1,930	
19	12,167	2,137	109,000 cu ft	-----		8 ea— 8	2,422	
21	15,468	3,605	110,293 cu ft	-----		10 ea— 5 4 ea—10	1,937	
17	12,550	----	67,000 cu ft	-----		4 ea— 1 6 ea— 3	3,146	
24	5,100	85	-----	2 ea—LCVP 2 ea—LCPR		1 ea— 5	162	
13	8,000	30	-----	-----		-----	76	700 vehicles. Ramp rated at 60 LTON.
18	13,000	8,050	60,000 sq ft 176,500 cu ft	-----		4 ea—10 16 ea—15 2 ea—60	12	
20	10,000	----	99,030 sq ft 946,800 cu ft	-----		-----	12	Incomplete data.

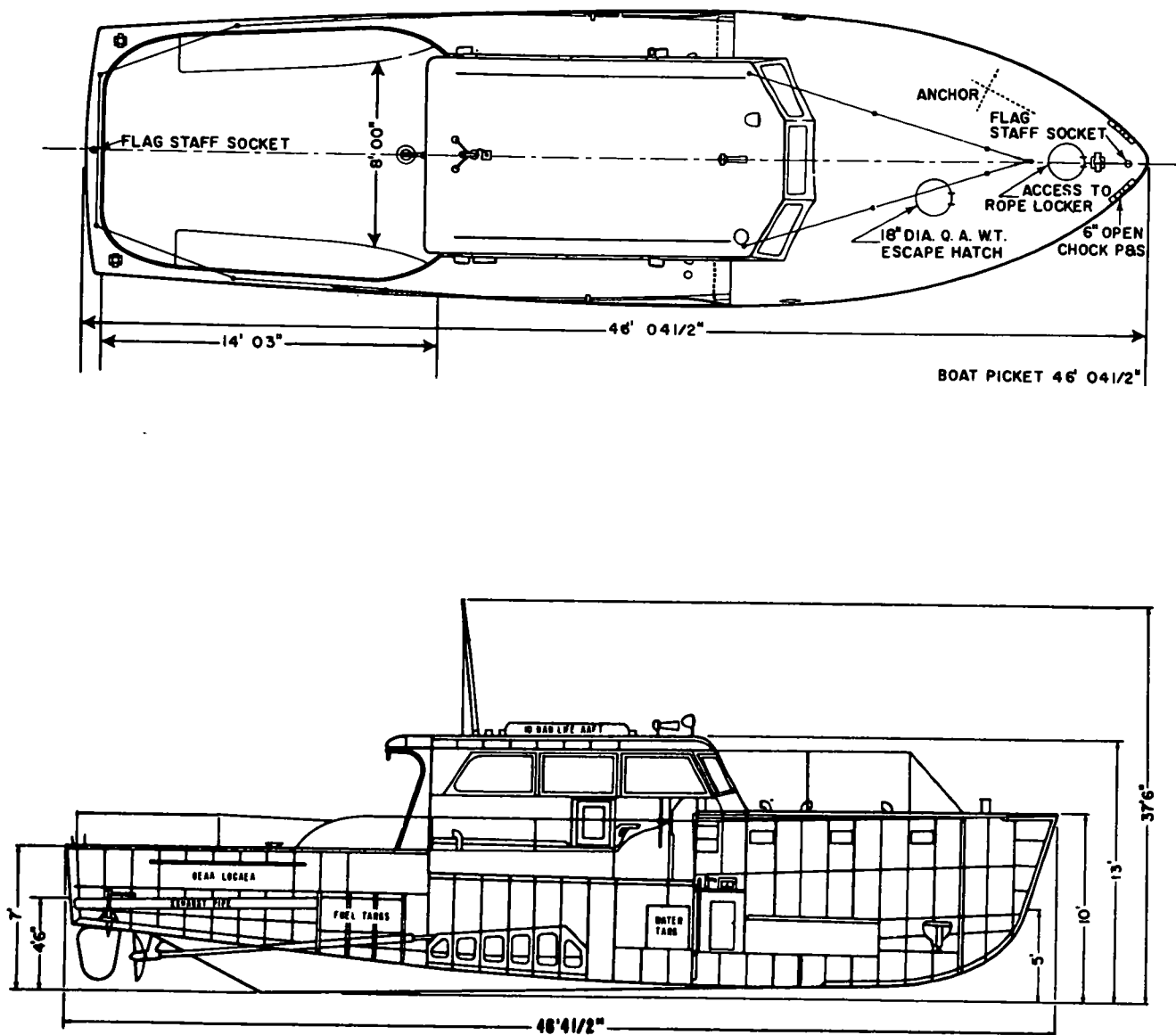


Figure 5-2. Boat, picket, steel, 46 feet 4½ inches design 4003.

5-12. Maritime Administration Vessel Classification System

a. Method. The classification system established by the United States Maritime Administration is based upon three groups of letters and numbers. The first group (prefix) indicates the type of vessel, such as cargo or passenger, and its approximate size. The second group (intermediate) indicates the type of machinery, number of screws, and passenger

accommodation. The third group (suffix) indicates the particular design of the type of vessel and modifications. For example: C2-S-AJ1 describes a cargo ship between 400 and 450 feet long (C2); single screw, steam machinery (S), and the AJ design (AJ), in its original version (1).

b. Prefix Designations.

(1) *Other than emergency and Victory types.*

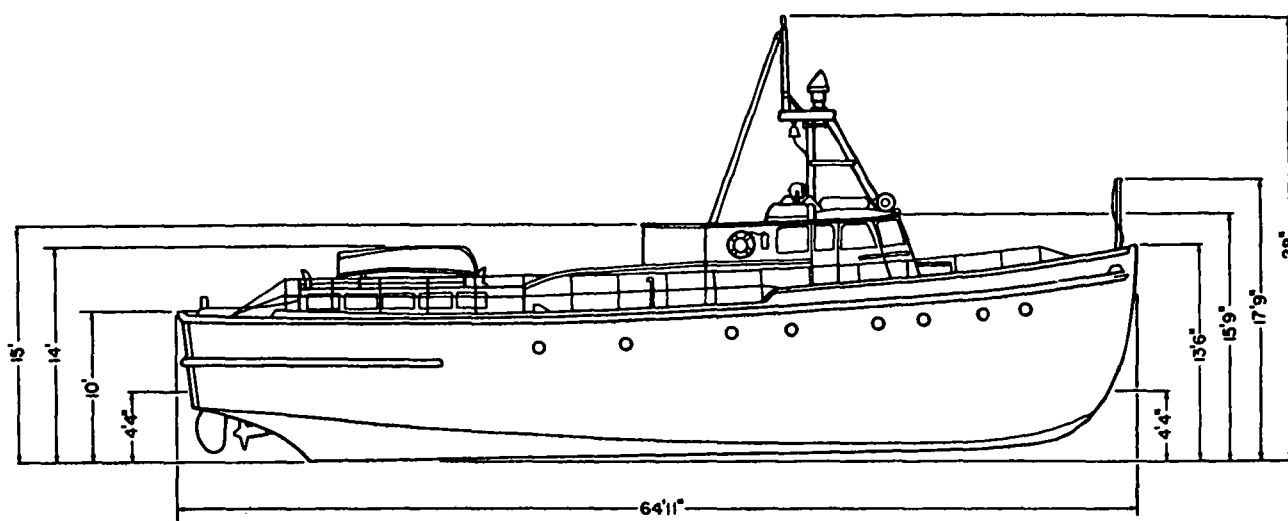


Figure 5-3. Boat, picket, diesel, wood, 64 feet 11 inches, design 4002.

Single letter	Class of vessel	1	2	Length designation (load waterline in feet)				6	7
C	Cargo, unlimited service, under 100 passengers.	Under 400	400-450	450-500	500-550				
P	Passenger, unlimited service, over 100 passengers.	Under 500	500-600	600-700	700-800	800-900	900-1,000		Over 1,000
B	Barge	Under 100	100-150	150-200	200-250	250-300			
L	Great Lakes tankers (ore, grain).	Under 400	400-450	450-500	500-550	550-600	600-650		
N	Coastwise cargo	Under 200	200-250	250-300	300-350	350-400	400-450	450-500	
R	Refrigerator	Under 400	400-450	450-500	500-550				
S	Special	Under 200	200-300	300-400	400-500	500-600	600-700		
T	Tanker	Under 450	450-500	500-550					
V	Towing vessels	Under 50	50-100	100-150	150-200				
Z	Conversion*								

*For conversions of established types, "Z" is prefixed to original designation with new final number in some cases.

(2) Emergency and Victory types. .

Double letter	Class of vessel	1	Length designation (load waterline in feet)				4
EC	Emergency cargo (Liberty ship)	Under 400	400-450	450-500			500-550
ET	Emergency tanker	450					
VC	Victory cargo	Under 400	400-450	450-500			500-550

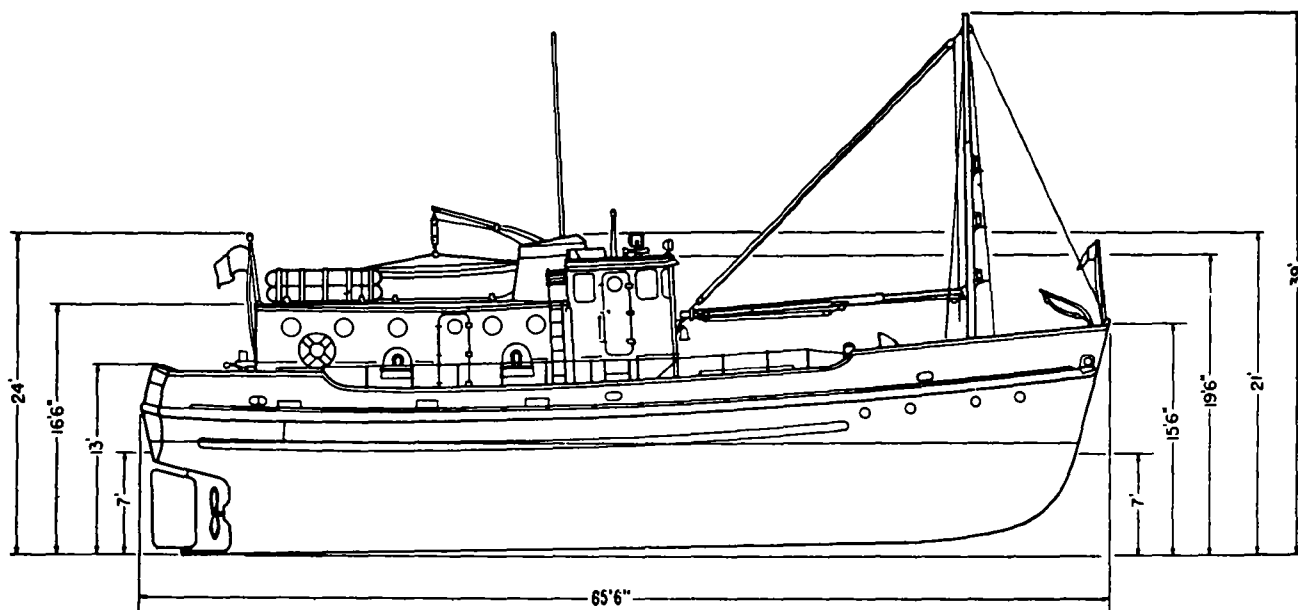
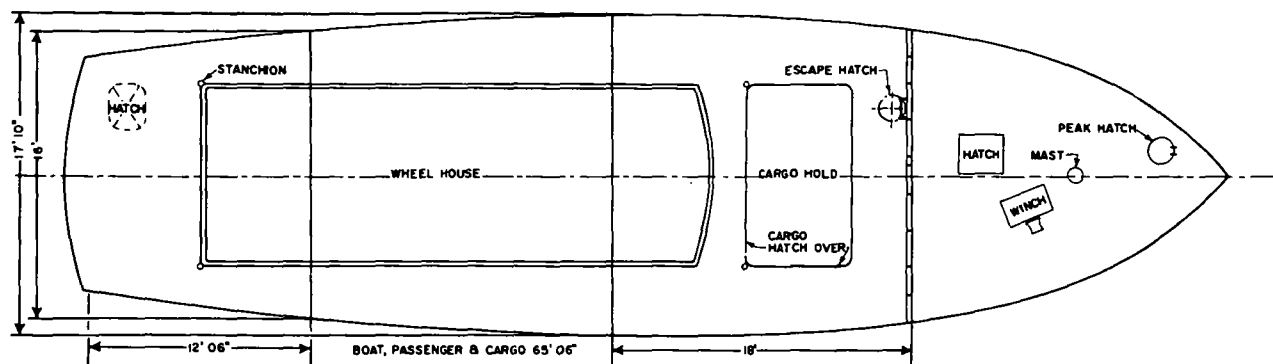


Figure 5-4. Boat, passenger and cargo, diesel, steel, 65 feet 6 inches, design 2001.

(3) *Older designs.* The following older designs have prefixes similar to those in (1) above, but do not follow the same system for the intermediate and suffix portions. The letters or words after the hyphen are simply distinguishing characters.

C1-A
C1-B
C2-Diesel

C2-F
C2-G
C2-Modified
C2-S
CT-Seas shipping
C2-SU Reefers
C2-T
C2-Turbine
C3-A (P&C)
C3-Diesel

C3-E
C3-IN (P&C)
C3-M
C3 (P&C) Diesel
C3 (P&C) Turbine
C3-P (P&C)
C3-Turbine

Type of machinery	Type of propeller	Under 12 passengers	Over 12 passengers
Gas turbine	Twin	GT	G2
Gas turboelectric ..	Twin	GET	GE2
Steam	Stern wheel	SW	SO
Motor	Stern wheel	MW	MO

c. Intermediate letter or group.

Type of machinery	Type of propeller	Under 12 passengers	Over 12 passengers
Steam	Single	S	S1
Motor	Single	M	M1
Turboelectric	Single	SE	SE1
Diesel-electric	Single	ME	ME1
Gas turbine	Single	G	G1
Gas turboelectric ..	Single	GE	GE1
Steam	Twin	ST	S2
Motor	Twin	MT	M2
Turboelectric	Twin	SET	SE2
Diesel-electric	Twin	MET	ME2

d. Suffix. The third group, or suffix, identifies the particular design and indicates the approximate time the design originated. The alphabetical letters are assigned in series. Therefore, if there is only one letter, this indicates that the design originated earlier than one having two letters. The figure following the letter or letters in the suffix indicates that it is either the original design of that particular alphabetical designation or a modification thereof. The original design is always numbered 1.

5-13. Below-Deck Capacities

Vessel (Hull design)	Hatch No.	Hatch dimensions	Upper 'tween	Cargo capacities (MTON)		
				Lower 'tween	Hold	Deep tanks
C1-B	1	29'3"x20'	481	398	862	
	2	31'6"x20'	750	742	1,438	
	3	31'6"x20'	845	779	1,222	
			^a 102			
	4	31'6"x20'	780	1,229		480
	5	31'6"x20'	574	608		
Total			3,532	3,756	3,522	480
C1-M-AV1	1	20'1½"x19'11"		601	616	
	2	40'5"x19'11"		982	1,378	
	3	40'5"x19'11"		901	1,179	
	4	9'x8'		^b 169	113	
Total				2,653	3,286	
C2-S-AJ	1	26'10"x19'10"	602	519	947	
	2	32'4"x19'10"	804	805	1,405	
	3	34'10"x19'10"	908	968	1,514	
	4	29'10"x19'10"	902	932	1,483	
	5	29'10"x19'10"	722		1,056	
Total			3,938	3,224	6,405	
EC2 (Liberty)	1	33'7"x19'10"		983	902	416
	2	34'10"x19'10"		1,065	2,300	
	3	19'10"x19'10"		597	1,495	613
	4	34'10"x19'10"		742	1,315	
	5	34'10"x19'10"		771	1,290	
Total				4,158	7,302	1,029
VC2 (Victory)	1	24'11"x22'3"	551	595	698	
	2	23'11"x22'3"	675	545	698	
	3	35'11"x22'3"	1,139	945	1,321	
	4	35'11"x22'3"	1,230		1,277	
	5	23'11"x22'3"	1,091		648	
Total			4,686	2,085	4,642	

See footnotes at end of chart.

Vessel (Hull design)	Hatch No.	Hatch dimensions	Cargo capacities (MTON)			
			Upper 'tween	Lower 'tween	Hold	Deep tanks
C3-S-A2 -----	1	35'9½"x19'9½"	812	1,130	1,079	
	2	29'9½"x23'9½"	830	1,381	1,396	
	3	37'3½"x23'9½"	1,244	1,553	2,002	
	4	29'9½"x23'9½"	1,164	1,255	1,419	
	5	39'9½"x23'9½"	1,009	1,704	212	
Total -----			5,059	7,023	6,108	
C4-S-A4 -----	1	17'9"x16'8"	^c 496	^d 340	141	
	2	26'10"x17'9"	^c 1,139	^d 1,258	772	
	3	26'10"x17'9"	798	651		^e 1,084
	4	26'10"x17'9"	803	^d 1,533	994	
	5	26'10"x17'9"	765	^d 1,515	1,017	
	6	26'10"x17'9"	795	782	1,636	
	7	17'9"x17'1"	^f 583	^f 454		
Total -----			5,379	6,533	4,560	1,084
C4-S-B5 -----	1	20'0"x18'0"	608	293		
	2	27'6"x20'0"	1,160	1,128	704	
	3	27'6"x20'0"	702	641	603	837
	4	30'0"x20'0"	^g 1,626	764	1,047	
	5	30'0"x20'0"	^g 1,623	772	1,055	
	6	30'0"x20'0"	^g 1,540	794	998	
	7	20'3"x18'0"	95	482	358	
Total -----			7,354	4,874	4,765	837
C4-S-1a (Mariner) -----	1	19'6"x17'9"	402	453	305	
	2	29'10"x23'10"	731	865	637	
	3	39'10"x29'10"	1,050	1,454	1,284	
	4	39'10"x29'10"	1,006	1,500	1,528	
	5	39'10"x29'10"	1,044	410	401	953
	6	39'10"x29'10"	965		1,646	298
	7	29'10"x24'10"	1,627		856	
Total -----			6,825	4,682	6,657	1,251
FS Freighter -----	1	20'0"x16'0"			251.8	
	2	28'0"x16'0"			284.75	
Total -----					536.55	

^a Special cargo locker on upper 'tween level between hatches Nos. 3 and 4.

^b Includes 36 MT in trunked hatch.

^c Includes upper deck and second deck.

^d Includes third deck and first platform.

^e Liquid cargo space.

^f Includes refrigerated cargo space.

^g Includes main 'tween deck.

5-14. Vehicles-Loading Capacities

These figures reflect general loading conditions and by no means represent the maximum vehicle capacities of the vessels. No allowance has been made for stacking or double

decking. All below-deck stowage is fore and aft except in the case of 1/4-ton trucks and 11/2-ton trailers, which are stowed both fore and aft and athwartship.

a. C4-S-1a (Mariner).

Hatch No.	Location	Trailer, cargo, 1 1/2-ton	Truck, utility, 1 1/4-ton	3/4 T 4 x 4	Truck, cargo 2 1/2 T 6 x 6 LWB	5 T 6 x 6 LWB
1	On deck -----	20	20	11	7	4
	'Tween deck:					
	Upper -----	16	20	12	6	4
	Lower -----	10	14	9	4	0
	Hold -----	5	9	6	3	0
2	On deck -----	23	33	20	10	7
	'Tween deck:					
	Upper -----	23	37	22	11	7
	Lower -----	21	26	15	9	7
	Hold -----	11	15	9	5	2
3	On deck -----	42	52	30	20	10
	'Tween deck:					
	Upper -----	48	61	38	25	13
	Lower -----	44	52	32	21	13
	Hold -----	32	36	22	14	9
4	On deck -----	36	52	26	18	10
	'Tween deck:					
	Upper -----	46	69	38	20	14
	Lower -----	46	69	38	20	14
	Hold -----	44	56	30	16	12
5	On deck -----	36	54	28	20	12
	'Tween deck:					
	Upper -----	56	72	42	18	14
	Lower -----	58	74	44	18	14
	Hold -----	56	72	42	16	12
	Deep tank -----	28	36	14	6	2
6	On deck -----	40	54	30	20	12
	'Tween deck -----	47	65	36	18	14
	Hold -----	30	34	20	12	9
	Deep tank -----	4	10	0	0	0
7	On deck -----	27	37	22	12	7
	'Tween deck -----	33	42	23	11	7
	Hold -----	9	10	6	4	0

b. C1-B.

Hatch No.	Location	Trailer, cargo, 1 1/2-ton	Truck, utility, 1 1/4-ton	3/4 T 4 x 4	Truck, cargo 2 1/2 T 6 x 6 LWB	5 T 6 x 6 LWB
1	On deck -----	14	14	12	5	7
	'Tween deck:					
	Upper -----	18	21	12	6	4
	Lower -----	18	21	12	6	5
	Lower hold -----	13	14	9	4	4
2	On deck -----	21	25	18	12	7
	'Tween deck:					
	Upper -----	37	46	25	13	12
	Lower -----	37	42	25	15	12
	Lower hold* -----	36	34	21	13	11
3	On deck -----	21	23	14	10	5
	'Tween deck:					
	Upper -----	42	44	30	17	12
	Lower -----	42	41	28	13	12
	Lower hold* -----	42	41	28	13	9

*See footnote at end of chart.

Hatch No.	Location	Trailer, cargo, 1 1/2-ton	Truck, utility, 1 1/4-ton	3/4 T & x 4	Truck, cargo 2 1/2 T 6 x 6 LWB	5 T 6 x 6 LWB
4	On deck -----	21	21	14	10	7
	'Tween deck:					
	Upper -----	41	39	26	14	12
	Lower -----	37	36	24	12	10
5	On deck -----	18	16	12	7	5
	'Tween deck -----	23	23	15	7	5
	Hold -----	10	10	12	6	6

*Number of vehicles (except 5-ton, 6 x 6) can be doubled by flooring over one layer of vehicles and loading a second layer directly on top. The depth of only these two holds will permit such double decking.

c. EC2 (Liberty).

Hatch No.	Location	Trailer, cargo, 1 1/2-ton	Truck, utility, 1 1/4-ton	3/4 T & x 4	Truck, cargo 2 1/2 T 6 x 6 LWB	5 T 6 x 6 LWB
1	On deck -----	22	22	14	9	6
	'Tween deck -----	27	28	23	12	8
	Lower hold -----	24	28	18	10	5
2	On deck -----	36	41	20	13	8
	'Tween deck -----	44	54	30	21	12
	Lower hold -----	42	48	*30	*18	12
3	On deck -----	14	22	10	6	4
	'Tween deck -----	28	36	25	14	6
	Lower hold -----	28	32	*22	12	6
4	On deck -----	20	31	16	11	8
	'Tween deck -----	37	41	27	16	8
	Lower hold -----	15	20	18	10	2
5	On deck -----	22	31	14	11	6
	'Tween deck -----	34	44	25	16	9
	Lower hold -----	11	20	20	6	2

*Based on no centerline bulkhead, which may or may not be standard equipment.

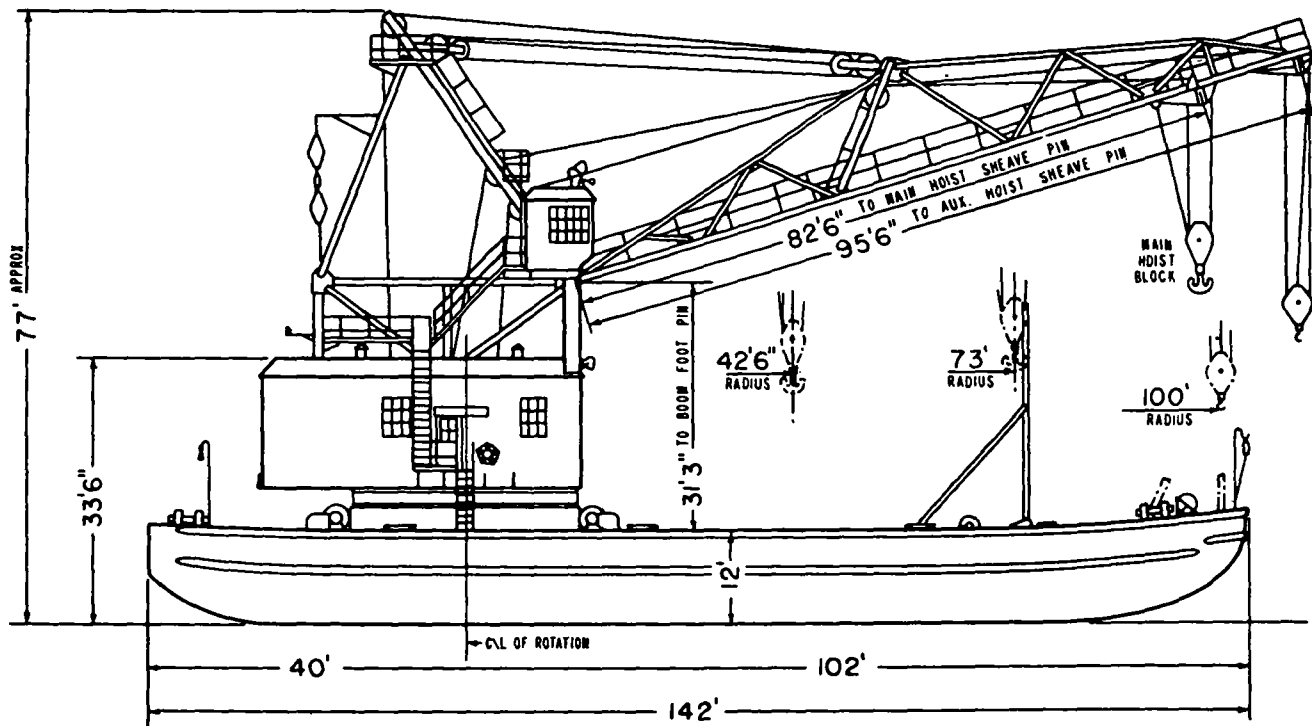


Figure 5-5. Crane, barge, diesel-electric, steel, 60 long tons, design 413D.

d. VC2 (Victory).

Hatch No.	Location	Trailer, cargo, 1 1/2-ton	Truck, utility, 1 1/4-ton	3/4 T 4 x 4	Truck, cargo 2 1/2 T 6 x 6 LWB	5 T 6 x 6 LWB
1	On deck -----	12	14	6	5	4
	'Tween deck:					
	Upper -----	16	15	9	5	0
	Lower -----	18	16	9	6	3
	Hold -----	13	15	8	4	3
2	On deck -----	16	18	12	7	4
	'Tween deck:					
	Upper -----	26	29	17	10	4
	Lower -----	24	25	17	10	5
	Hold -----	21	21	14	8	3
3	On deck -----	29	25	18	13	8
	'Tween deck:					
	Upper -----	48	48	29	17	12
	Lower -----	46	46	30	18	12
	Hold -----	46	44	30	18	8
4	On deck -----	25	23	18	13	8
	'Tween deck -----	48	49	34	16	14
	Hold -----	49	49	31	18	13
5	On deck -----	25	25	17	6	4
	'Tween deck -----	31	30	20	12	6
	Hold -----	19	20	12	7	3

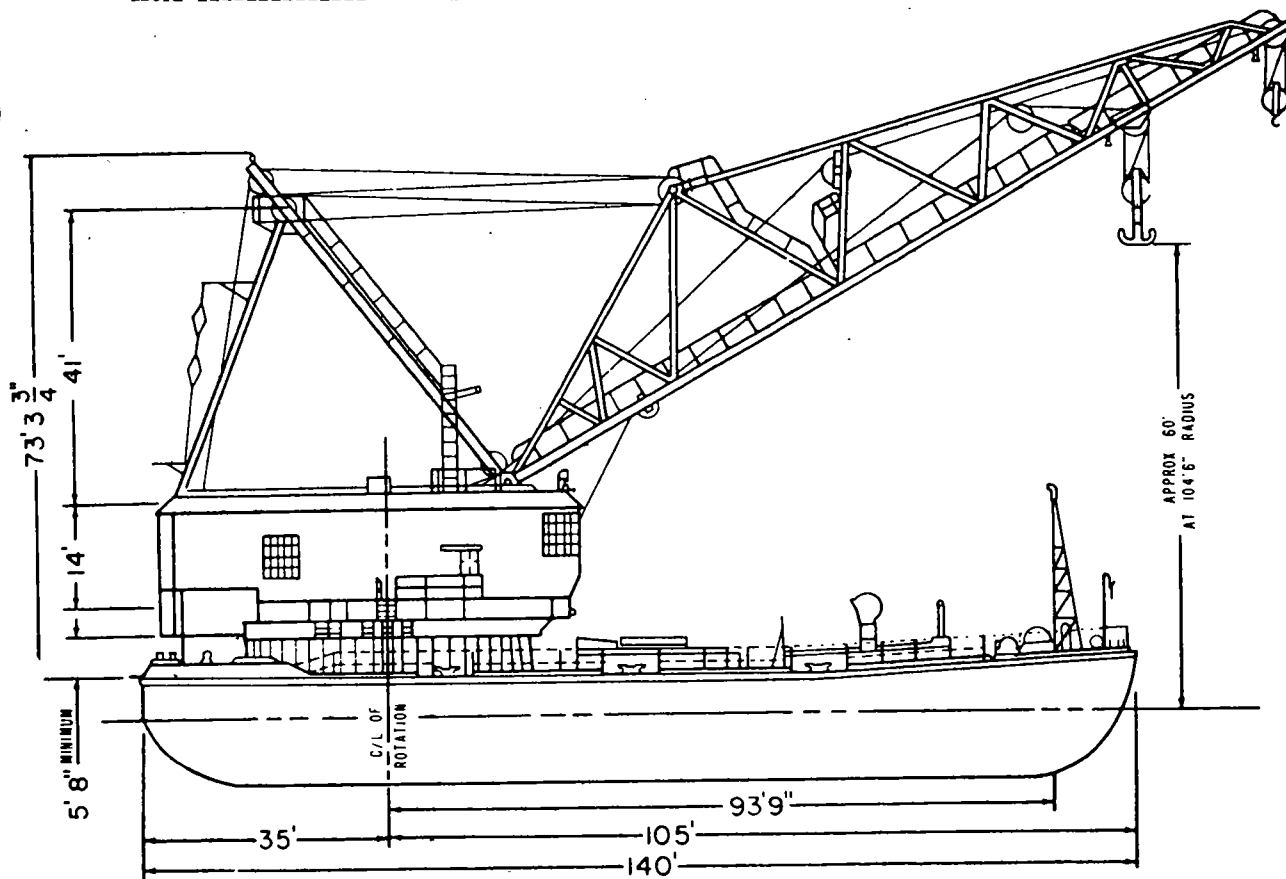


Figure 5-6. Crane, barge, diesel-electric, revolving, steel, 89 long tons, design 264B.

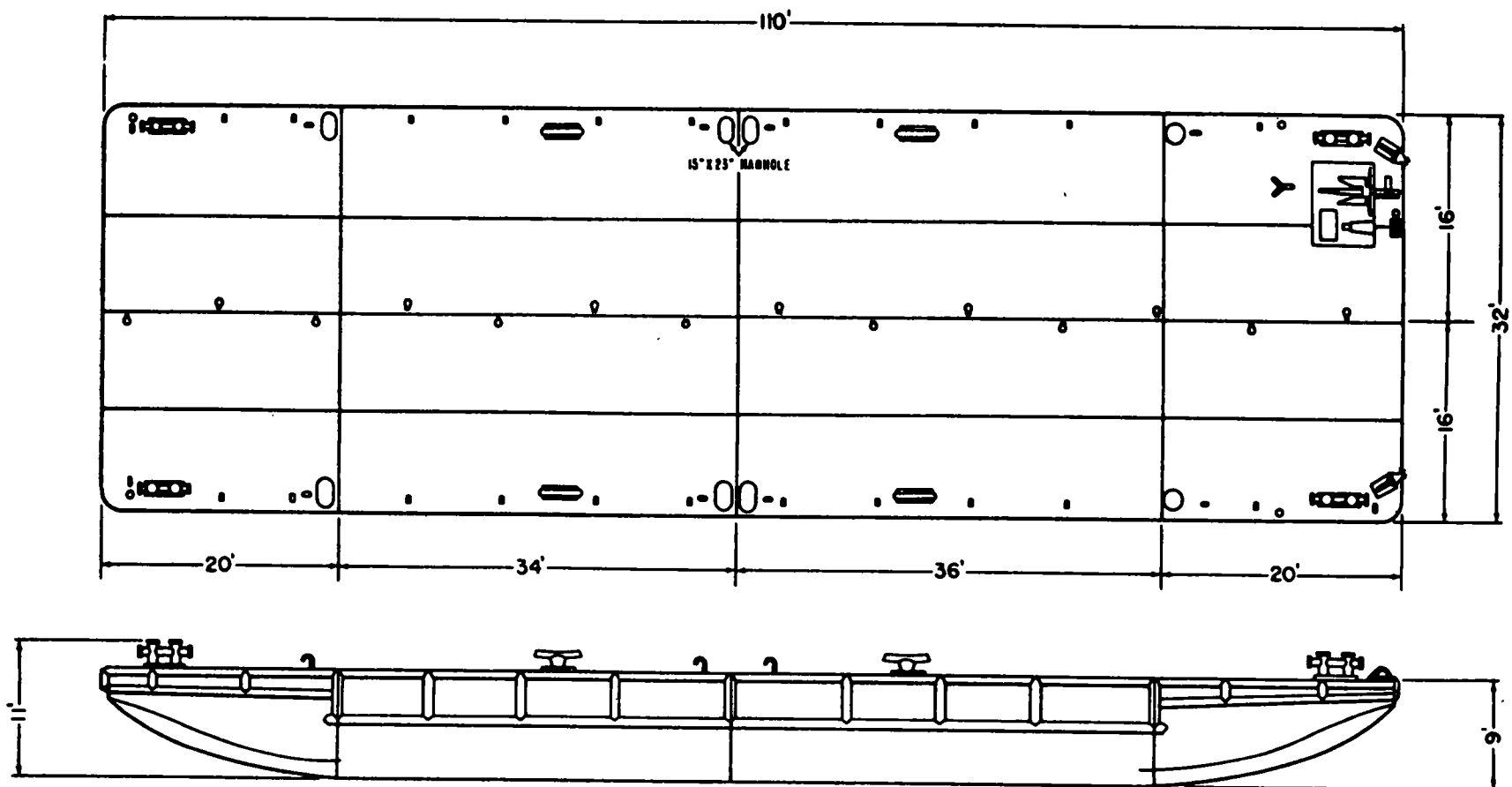


Figure 5-7. Barge, deck cargo, nonpropelled, steel 570 tons, 110 feet, design 7005.

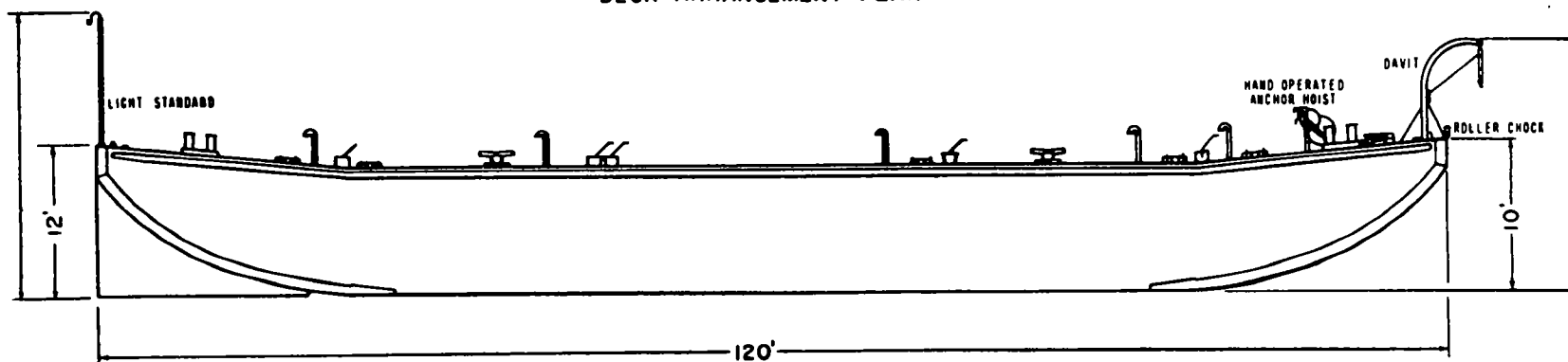
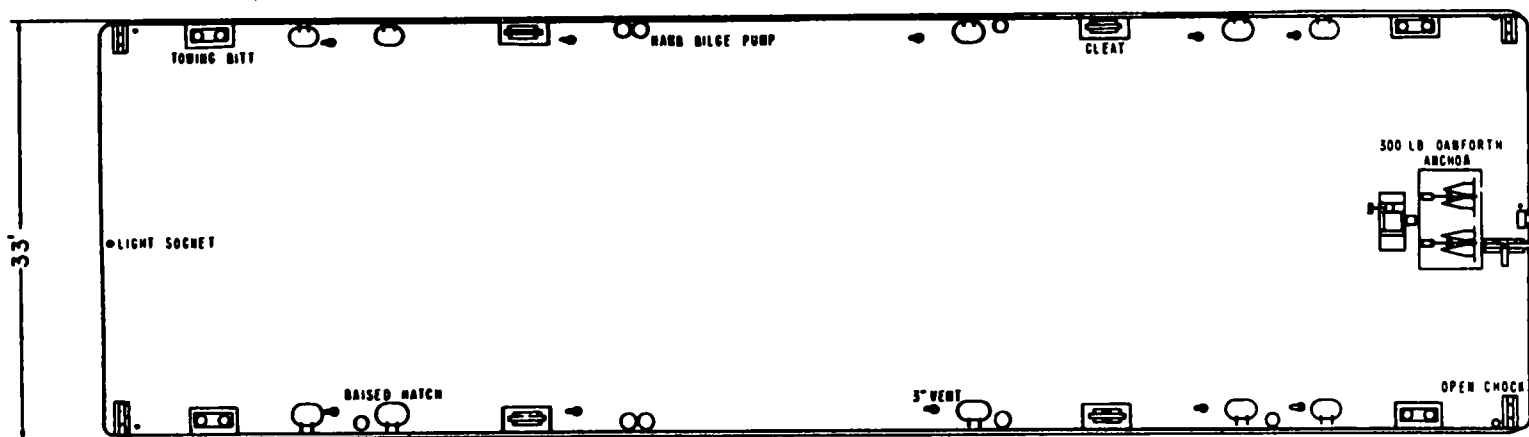


Figure 5-8. Barge, deck, cargo, nonpropelled, steel, 585 tons, 120 feet, design 231A.

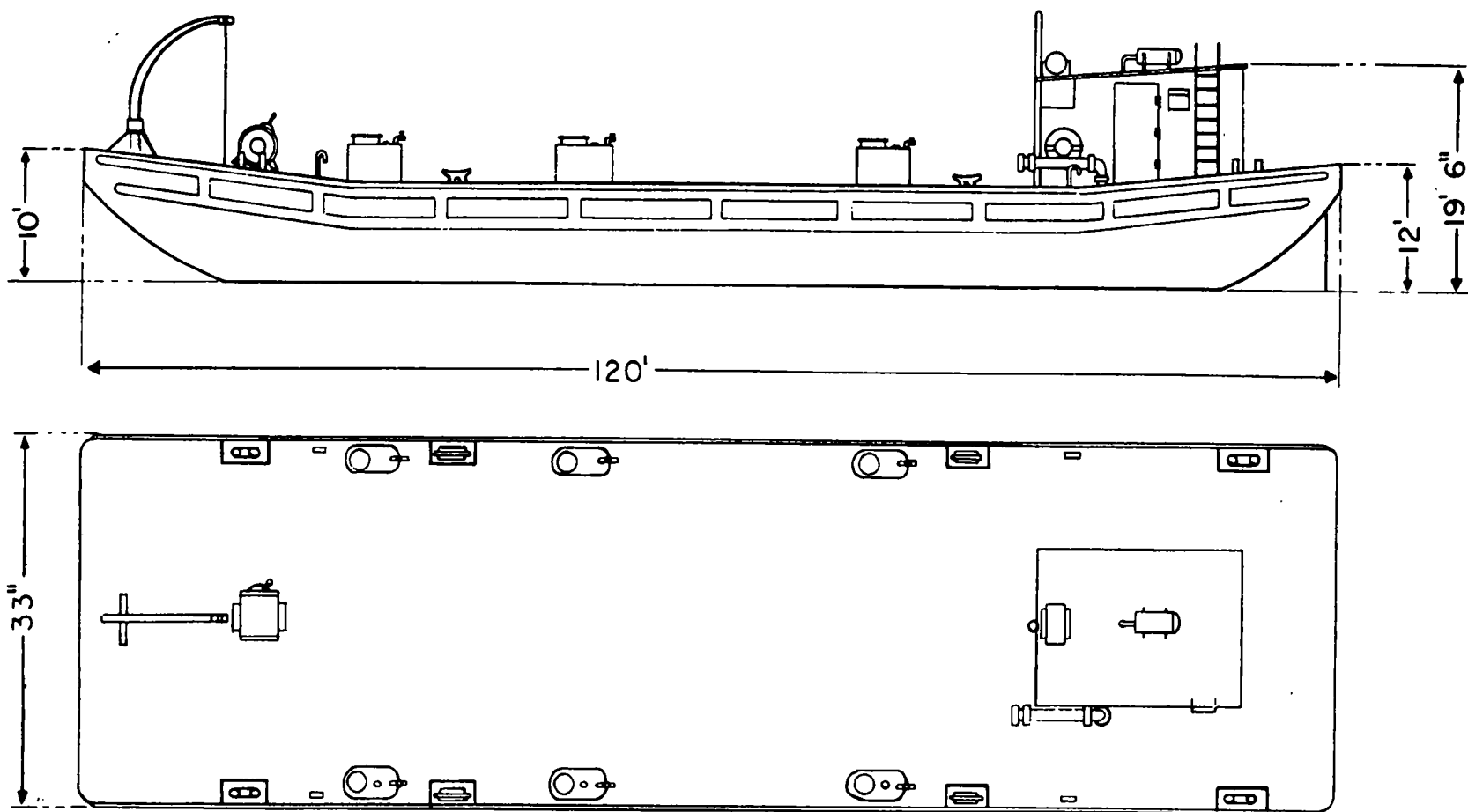


Figure 5-9. Barge, deck and liquid cargo, nonpropelled, steel, 578 tons or 4,160 barrels, 120 feet, design 231B.

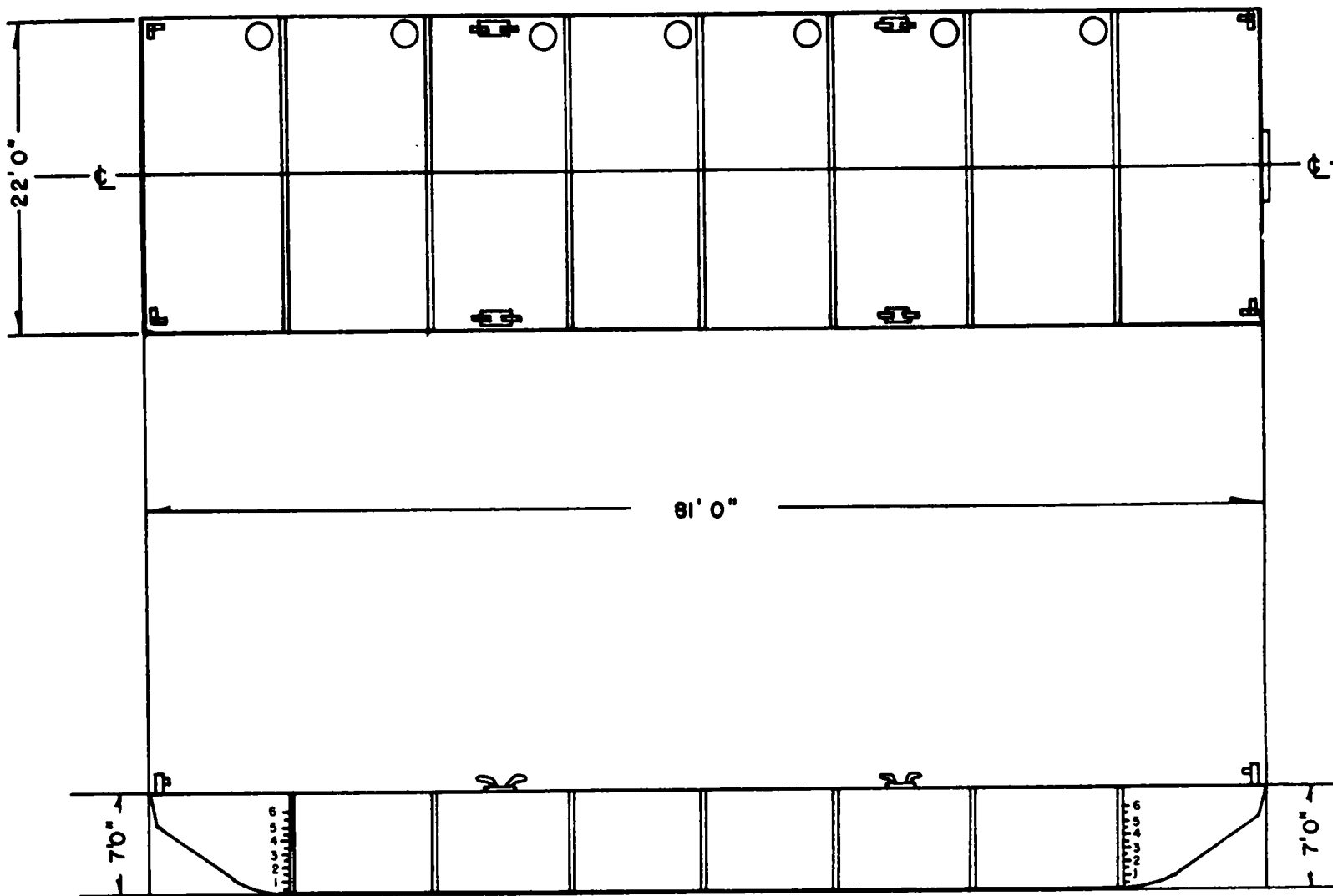


Figure 5-10. Barge, deck cargo, nonpropelled, steel, 130 tons, 81 feet, sectionalized, nesting, design 7001.

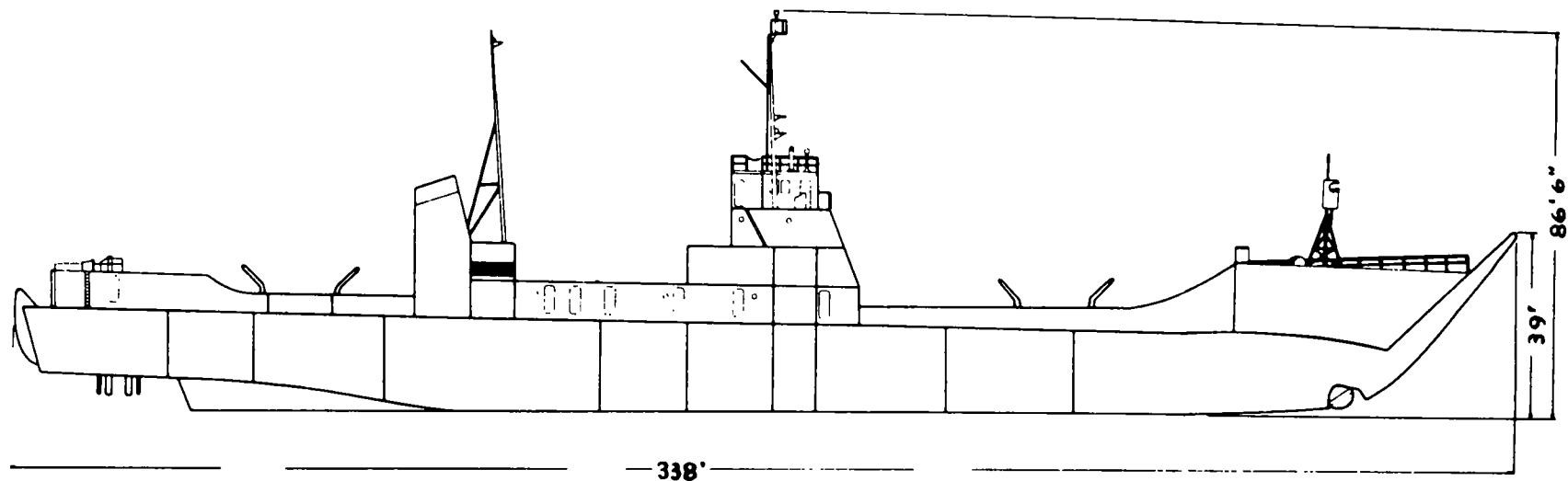


Figure 5-11. Lighter, beach discharge, deck cargo, diesel, steel, 338 feet, design 5002.

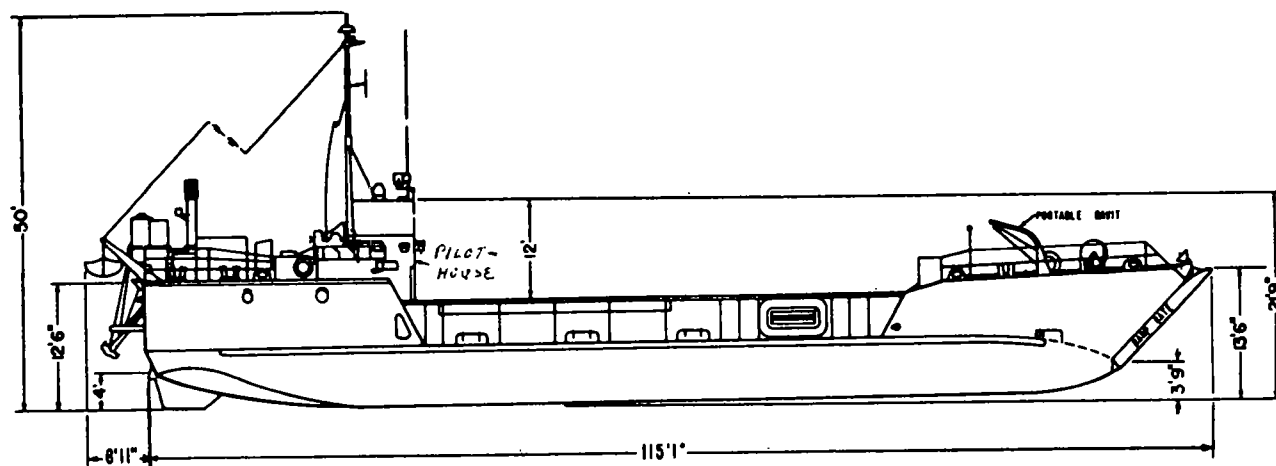
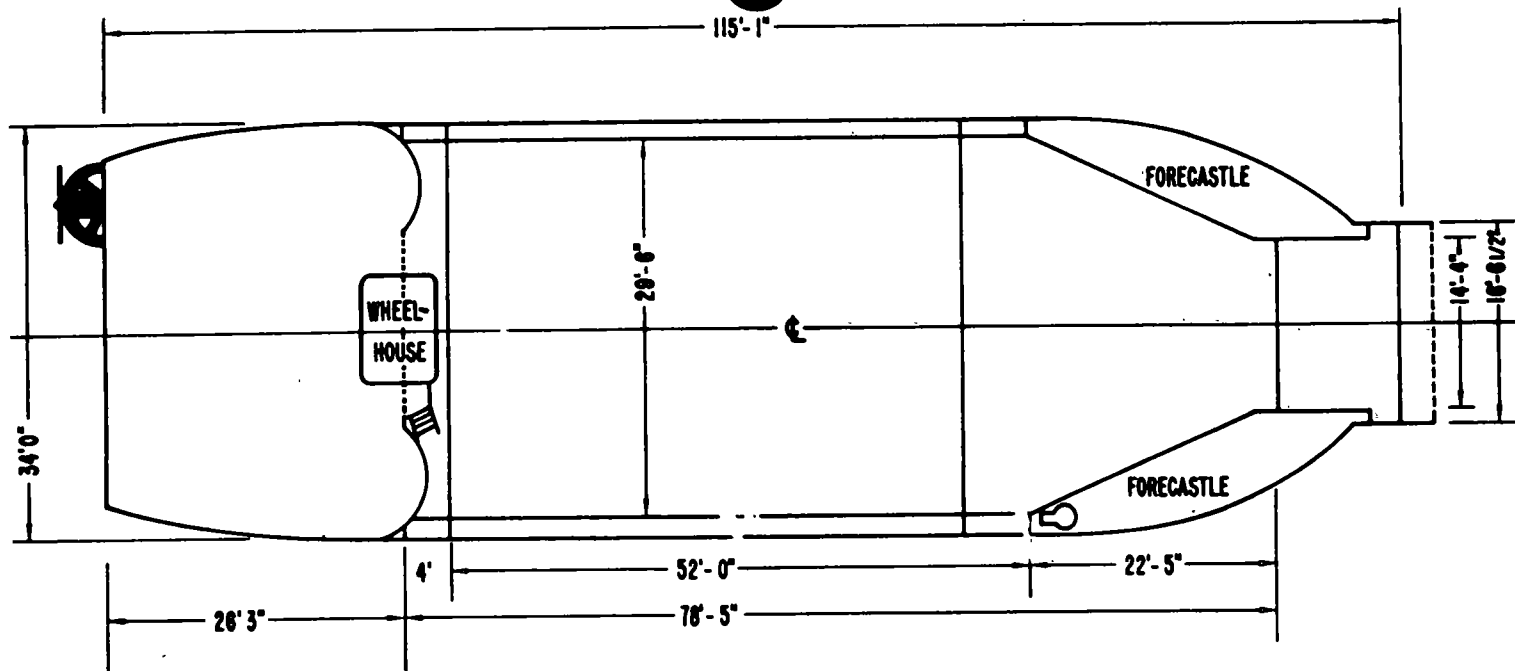


Figure 5-12. Landing craft, utility, diesel, steel, 115 feet, Navy design, LCU 1466 class.

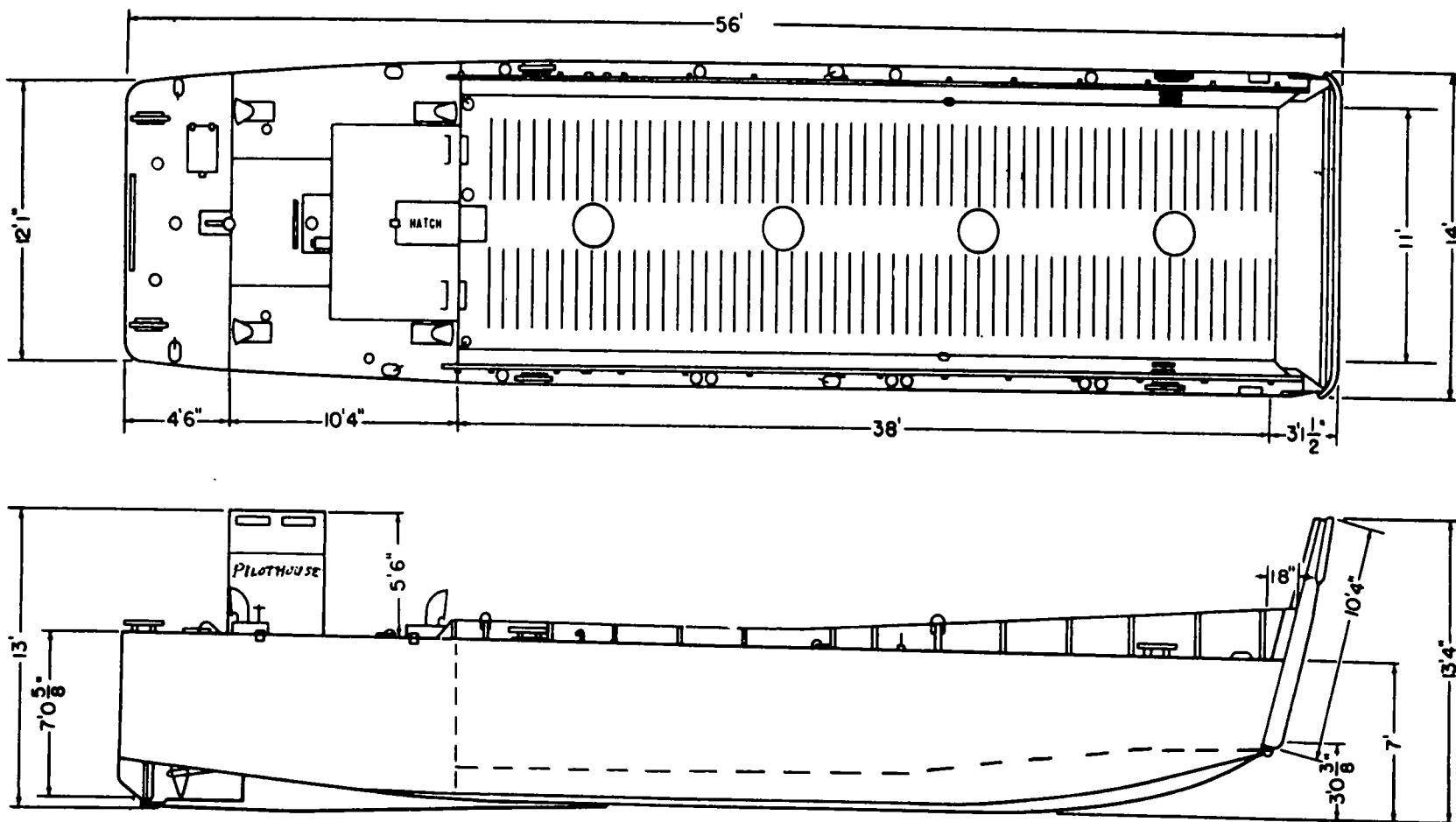


Figure 5-13. Landing craft, mechanized, diesel, 56 feet, Mark VI, Navy design, LCM (6).

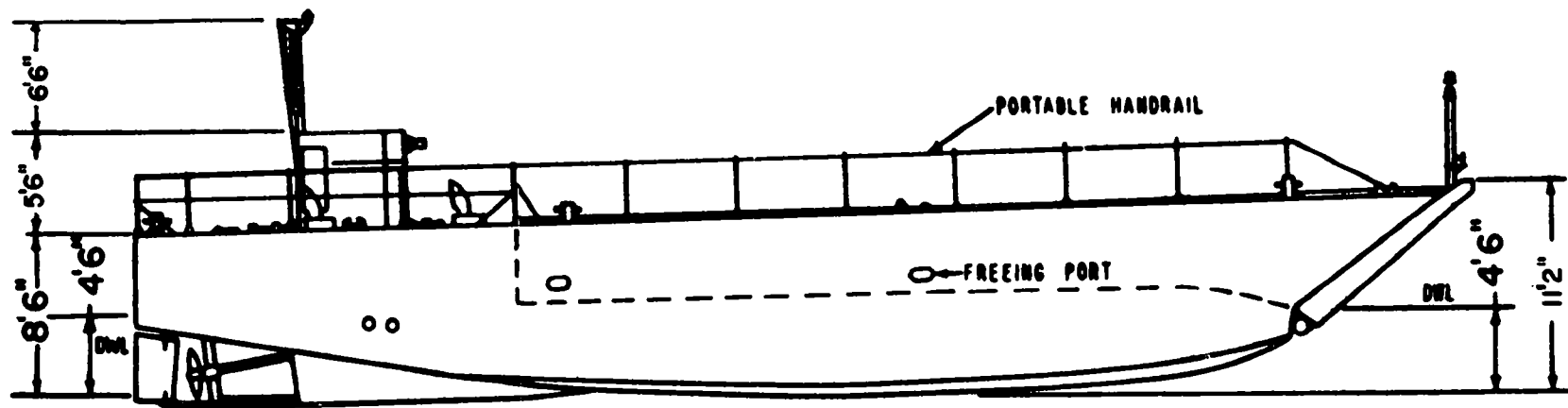
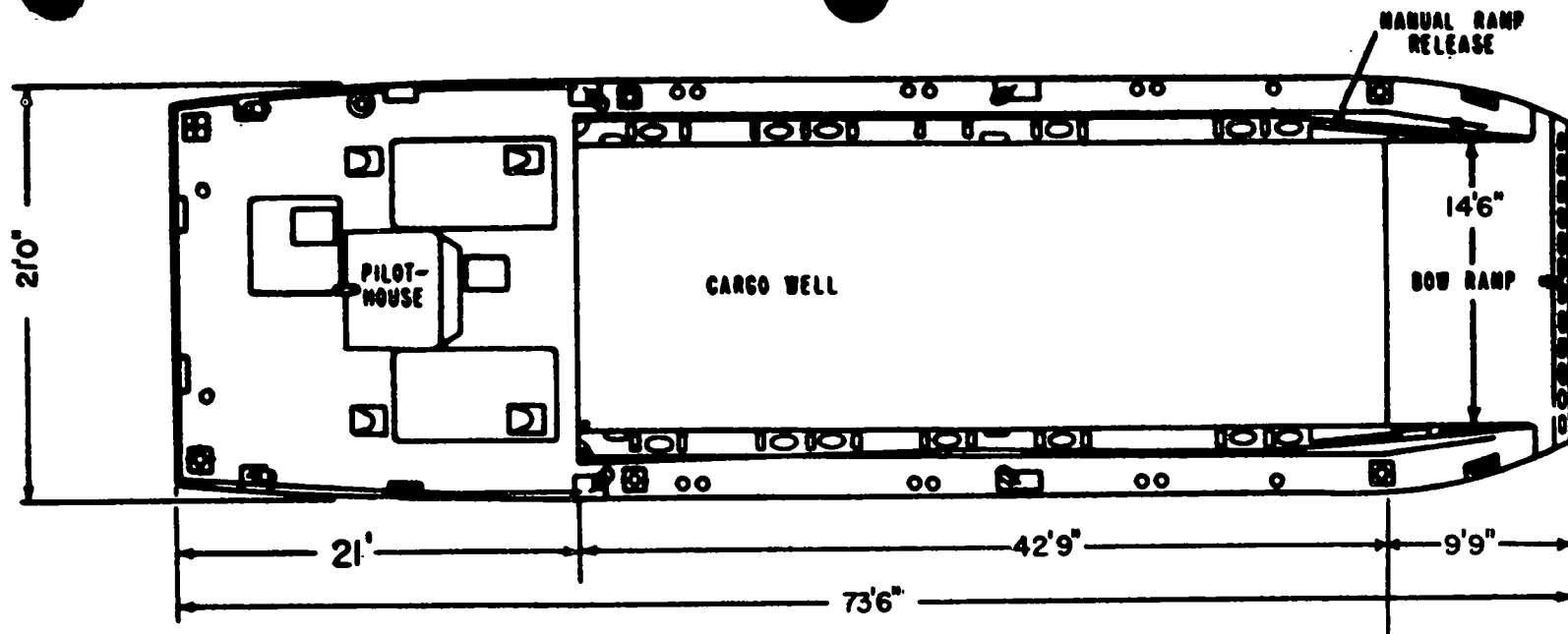


Figure 5-14. Landing craft, mechanized, diesel, steel, 69 feet, Mark VIII, Navy design, LCM (8).

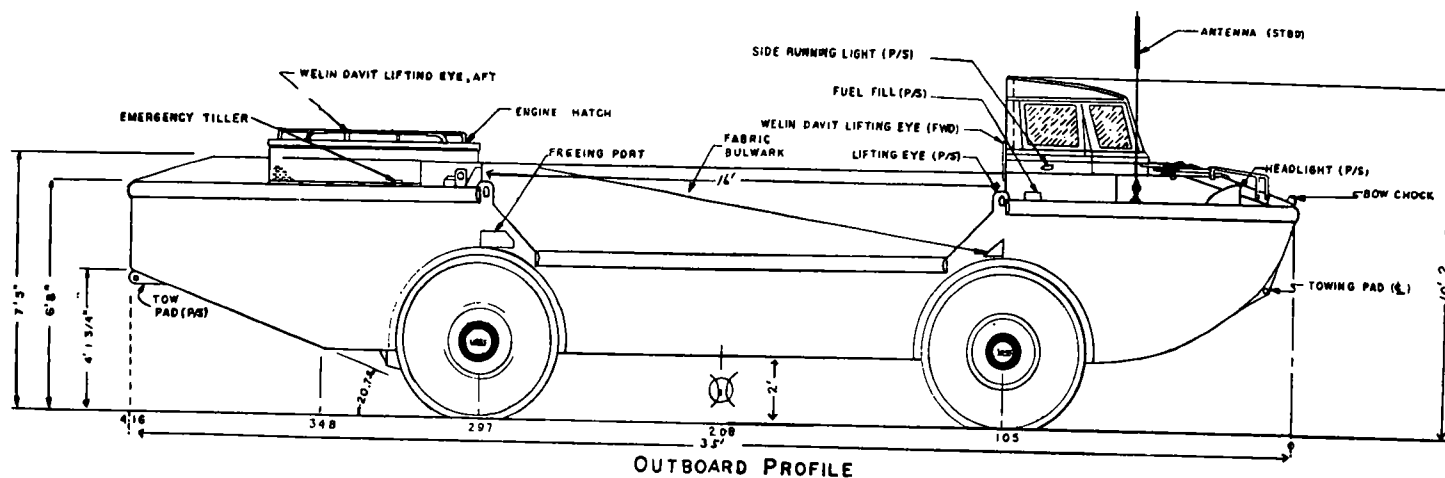
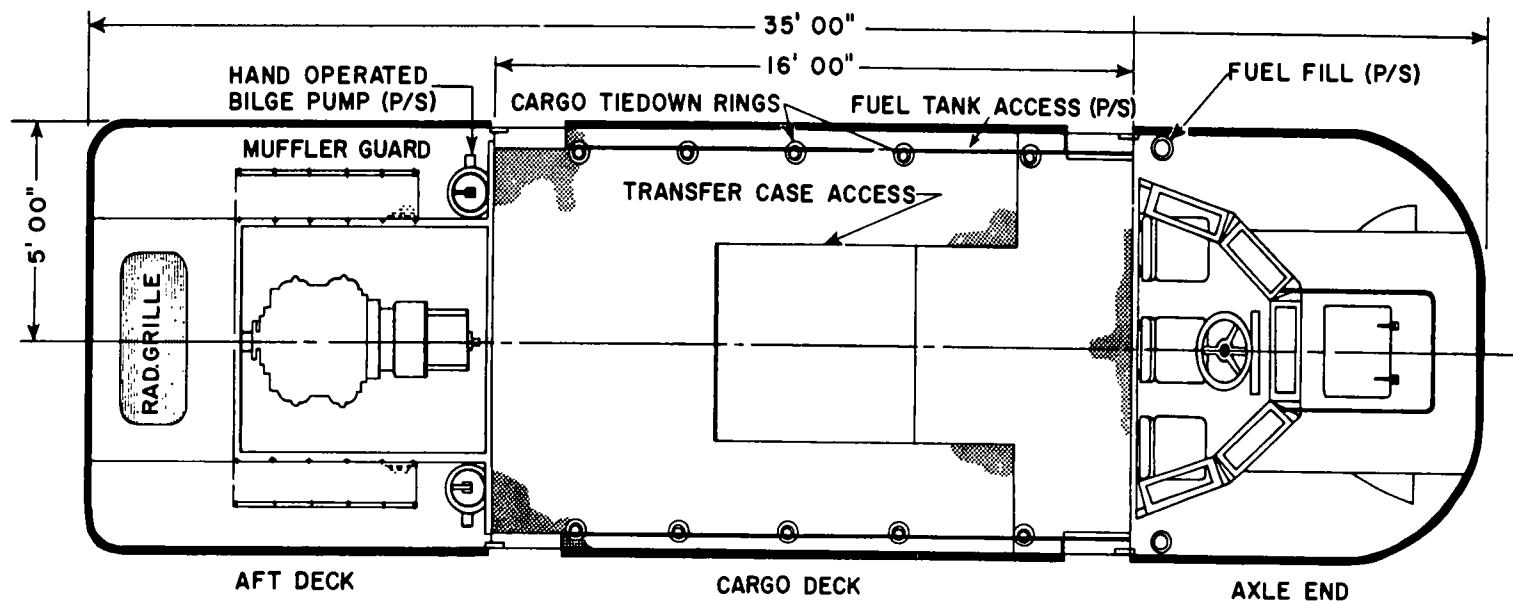


Figure 5-15. Lighter, amphibious (LARC-V), self-propelled, diesel, aluminum, 5 tons, design 8005.

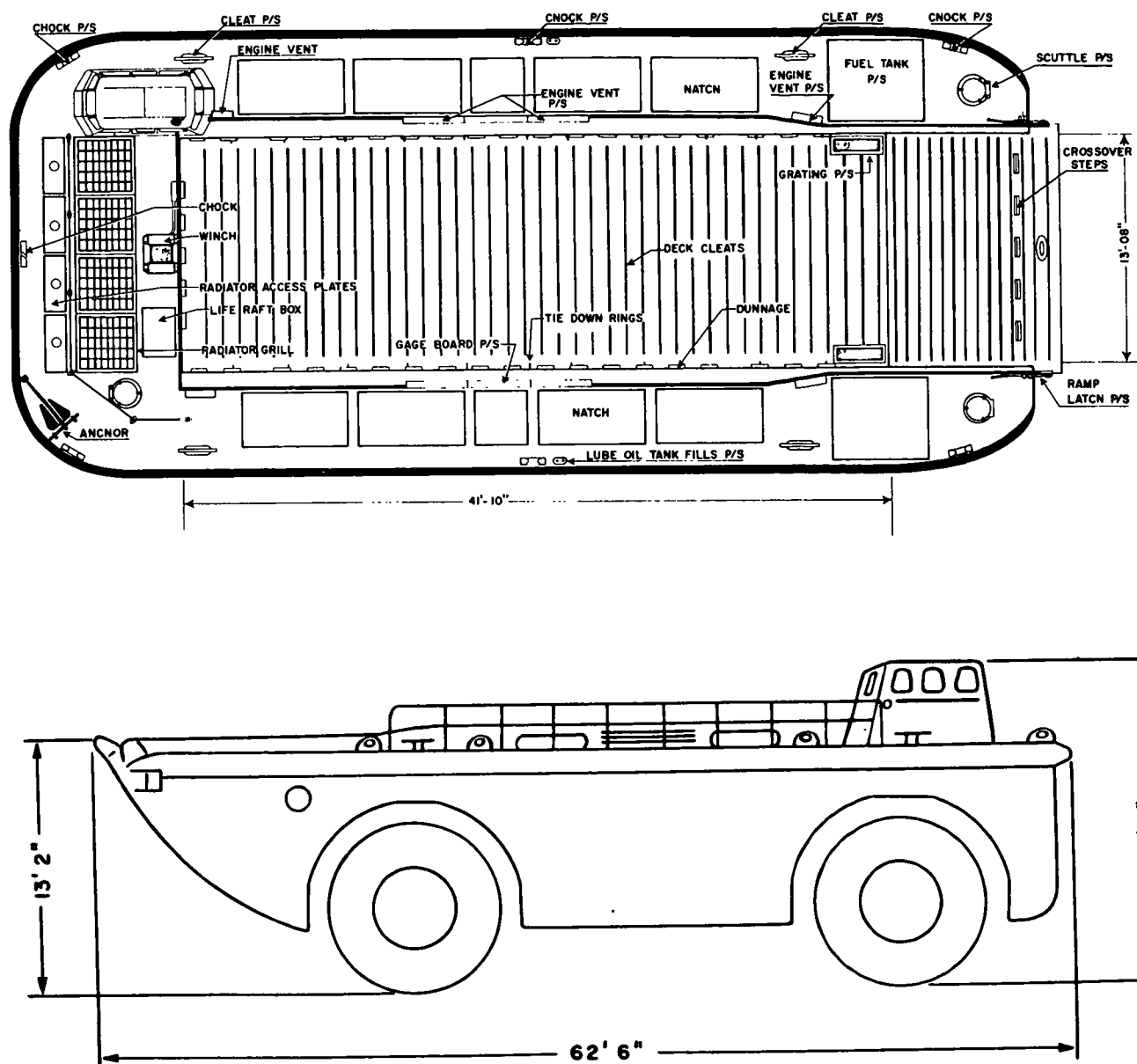


Figure 5-16. Lighter, amphibious (LARC-LX), self-propelled, diesel, steel, 60 tons, 61 feet, design 2303.

e. C1-M-AV1.*

Hatch No.	Location	Trailer, cargo, 1 1/2-ton	Truck, utility, 1 1/4-ton	3/4 T & x 4	Truck, cargo 2 1/2 T 8 x 6 LWB	5 T 8 x 6 LWB
1	On deck -----	14	20	13	7	4
	'Tween deck -----	23	30	16	10	3
	Hold -----	13	16	7	4	2
2	On deck -----	24	30	18	10	8
	'Tween deck -----	46	51	28	19	10
	Hold -----	45	51	28	19	10
3	On deck -----	22	28	14	10	6
	'Tween deck -----	37	44	27	17	9
	Hold -----	37	44	26	15	9

*No. 4 hatch is not large enough for vehicle loading.

5-15. United States Navy Ship and Service Craft Designators

In the following lists the arrangement within the major categories and subcategories is alphabetically by symbols.

Where the identifying classification and hull number of a naval vessel is preceded by the letter "E," it indicates that the particular vessel or craft is "Experimental." Similarly the prefix "T" indicates that the vessel is assigned to MSTS (Military Sea Transportation Service).

The addition of the suffix "N" to the identifying classification indicates that that particular vessel has nuclear propulsion.

a. Combatant Vessels.

(1) Warships.

Aircraft Carriers:

Attack Aircraft Carrier	CVA
Nuclear Power Aircraft Carrier ..	CVAN
Small Aircraft Carrier	CVL
ASW Support Aircraft Carrier	CVS

Battleships:

Battleship	BB
------------------	----

Cruisers:

Heavy Cruiser	CA
Guided Missile Heavy Cruiser	CAG
Guided Missile Cruiser	CG
Nuclear Power Guided Missile Cruiser	CGN
Light Cruiser	CL
Anti-Aircraft Light Cruiser	CLAA
Guided Missile Light Cruiser	CLG

Destroyers:

Destroyer	DD
Nuclear Power Destroyer	DDN
Guided Missile Destroyer	DDG
Radar Picket Destroyer	DDR
Frigate	DL
Guided Missile Frigate	DLG
Nuclear Power Guided Missile Frigate	DLGN

Submarines:

Submarine	SS
Fleet Ballistic Missile Submarine ..	SSB
Nuclear Power Fleet Ballistic Missile Submarine	SSBN
Guided Missile Submarine	SSG
Nuclear Power Guided Missile Submarine	SSGN
Nuclear Power Submarine	SSN

(2) Amphibious Warfare Ships.

Amphibious Force Flagship	AGC
Attack Cargo Ship	AKA
Attack Transport	APA
High Speed Transport	APD
Transport Submarine	APSS
Inshore Fire Support Ship	IFS
Amphibious Transport Dock	LPD
Amphibious Assault Ship	LPH
Dock Landing Ship	LSD
Medium Landing Ship	LSM
Medium Landing Ship (Rocket) ..	LSMR
Support Landing Ship (Large)	
Mk. III	LSSL
Tank Landing Ship	LST
Vehicle Cargo Ship	LSV

(3) Mine Warfare Ships.

Minelayer, Destroyer	DM
Mine Countermeasures Support Ship	MCS
Minehunter, Auxiliary	MHA
Minehunter, Coastal	MHC
Minelayer, Fleet	MMF
Minelayer, Auxiliary	MMA
Minelayer, Coastal	MMC
Minesweeper, Auxiliary	MSA
Minesweeper, Coastal	MSC
Minesweeper, Coastal (old)	MSC(o)
Minesweeper, Fleet (steel hulled) ..	MSF
Minesweeper, Ocean (Nonmagnetic) ..	MSO
Minesweeper, Special	MSS

(4) Patrol Ships.

Escort Ship	DE
Guided Missile Escort Ship	DEG
Radar Picket Escort Ship	DER
Submarine Chaser (173')	PC
Escort (180')	PCE
Rescue Escort (180')	PCER
Submarine Chaser (Hydrofoil)	PCH
Submarine Chaser (136')	PCH
Patrol Escort	PF
Motor Gunboat	PGM
Fast Patrol Boat	PTF
Yacht	PY
Submarine Chaser (110')	SC

(5) Command Ships.

Command Ship	CC
--------------------	----

b. Auxiliary Ships.

Destroyer Tender	AD
Degaussing Ship	ADG
Ammunition Ship	AE
Store Ship	AF
Combat Store Ship	AFS
Miscellaneous	AG
Icebreaker	AGB
Escort Research Ship	AGDE
Hydrofoil Research Ship	AGEH

Missile Range Instrumentation Ship	AGM
Major Communications Relay Ship	AGMR
Oceanographic Research Ship	AGOR
Radar Picket Ship	AGR
Surveying Ship	AGS
Coastal Surveying Ship	AGSC
Satellite Launching Ship	AGSL
Auxiliary Submarine	AGSS
Hospital Ship	AH
Cargo Ship	AK
Cargo Ship, Dock	AKD
Light Cargo Ship	AKL
Net Cargo Ship	AKN
Stores Issue Ship	AKS
Cargo Ship and Aircraft Ferry	AKV
Net Laying Ship	AN
Oiler	AO
Fast Combat Support Ship	AOE
Gasoline Tanker	AOG
Replenishment Fleet Tanker	AOR
Submarine Oiler	AOSS
Transport	AP
Self-propelled Barracks Ship	APB
Small Coastal Transport	APC
Repair Ship	AR
Battle Damage Repair Ship	ARB
Cable Repairing or Laying Ship	ARC
Internal Combustion Engine Repair Ship	ARG
Landing Craft Repair Ship	ARL
Salvage Ship	ARS
Salvage Lifting Ship	ARSD
Salvage Craft Tender	ARST
Aircraft Repair Ship	ARV
Aircraft Repair Ship (Aircraft)	ARVA
Aircraft Repair Ship (Engine)	ARVE
Submarine Tender	AS
Submarine Rescue Ship	ASR
Auxiliary Ocean Tug	ATA
Fleet Ocean Tug	ATF
Seaplane Tender	AV
Advance Aviation Base Ship	AVB
Guided Missile Ship	AVM
Small Seaplane Tender	AVP
Aviation Supply Ship	AVS
Auxiliary Aircraft Transport	AVT
Distilling Ship	AW
Unclassified Miscellaneous	IX

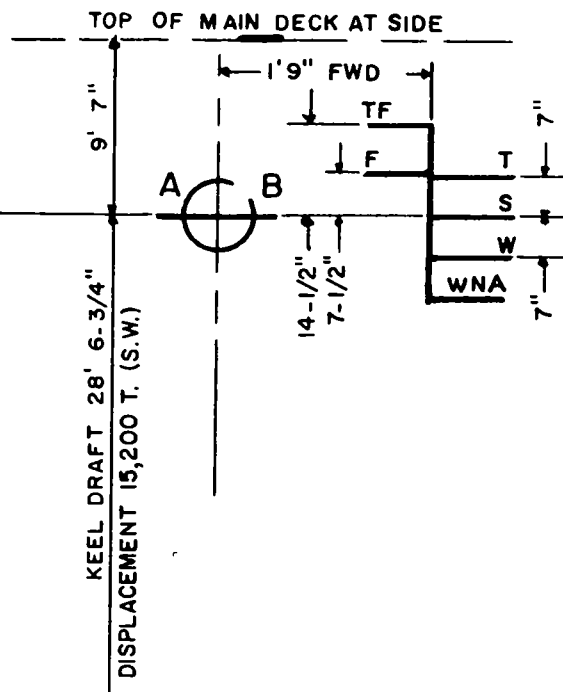
c. Service Craft.

Large Auxiliary Floating Dry Dock	AFDB
Small Auxiliary Floating Dry Dock	AFDL
Medium Auxiliary Floating Dry Dock	AFDM
Barracks Ship (non-self-propelled)	APL
Auxiliary Repair Dry Dock	ARD
Medium Auxiliary Repair Dry Dock	ARDM
*Utility Landing Craft (see footnote at end of chart)	LCU
Minesweeping Boat	MSB

Minesweeper, Inshore	MSI
Target and Training Submarine	SST
Submersible Craft	X
Miscellaneous Auxiliary	YAG
Open Lighter	YC
Car Float	YCF
Aircraft Transportation Lighter	YCV
Floating Crane	YD
Diving Tender	YDT
Covered Lighter (self-propelled)	YF
Ferryboat or Launch	YFB
Yard Floating Dry Dock	YFD
Covered Lighter (non-self- propelled)	YFN
Large Covered Lighter	YFNB
Dry Dock Companion Craft	YFND
Lighter (special purpose)	YFNX
Floating Power Barge	YFP
Refrigerated Covered Lighter (self-propelled)	YFR
Refrigerated Covered Lighter (non- self-propelled)	YFRN
Covered Lighter (Range Tender)	YFRT
Harbour Utility Craft	YFU
Garbage Lighter (self-propelled)	YG
Garbage Lighter (non-self- propelled)	YGN
Dredge	YM
Gate Craft	YNG
Fuel Oil Barge (self-propelled)	YO
Gasoline Barge (self-propelled)	YOG
Gasoline Barge (non-self-propelled)	YOGN
Fuel Oil Barge (non-self-propelled)	YON
Oil Storage Barge	YOS
Patrol Craft	YP
Floating Pile Driver	YPD
Floating Workshop	YR
Repair and Berthing Barge	YRB
Repair, Berthing and Messing Barge	YRBM
Floating Dry Dock Workshop (Hull)	YRDH
Floating Dry Dock Workshop (Mach.)	YRDM
Radiological Repair Barge	YRR
Seaplane Wreckage Derrick	YSD
Sludge Removal Barge	YSR
Large Harbour Tug	YTB
Small Harbour Tug	YTL
Medium Harbour Tug	YTM
Drone Aircraft Catapult Control Craft	YV
Water Barge (self-propelled)	YW
Water Barge (non-self-propelled)	YWN

*All LCU's, Utility Landing Craft, were reclassified from "Service Craft" to "Boats" in Nov. 1958.

DEADWEIGHT SCALE			
A	B	C	D
11,000	29		
	28	15,000	51.0
10,000	27		
	26	14,000	
9,000	25		500
	24	13,000	
8,000	23		490
	22	12,000	
7,000	21		480
	20	11,000	
6,000	19		470
	18	10,000	
5,000	17		460
	16	9,000	
4,000	15		450
	14	8,000	
3,000	13		440
	12	7,000	
2,000	11		430
	10	6,000	
1,000	9		420
	8	5,000	
0		4,000	



Legend

- A - Deadweight tons, salt water
- B - Draft (feet) to bottom of keel
- C - Displacement tons, salt water
- D - Tons per inch immersion

Figure 5-17. Deadweight scale for a Victory ship.

5-16. U.S. Army Marine Fleet Classification System

Each vessel in the transportation terminal battalion marine fleet bears an individual serial number, preceded by one of the following applicable prefixes.

LARC (LX)	lighter, amphibious, self-propelled, diesel, steel, 60-ton, 61-foot, design 2303
BC	barge, dry cargo, nonpropelled, medium (100 feet through 149 feet)
BCDK	conversion kit, barge, deck enclosure
BCI	barge, dry cargo, inland waterways, nonpropelled, medium (100 feet through 149 feet)
BCLI	barge, dry cargo, inland waterways, nonpropelled, large (150 feet and over)
BPC	barge, railroad carfloat
BCS	nested barge
BD	crane, floating
BDL	lighter, beach discharge
BG	barge, liquid cargo, nonpropelled
BGI	barge, liquid cargo, inland waterways, nonpropelled
BK	barge, dry cargo, nonpropelled
BKI	barge, dry cargo, inland waterways, nonpropelled
BPL	barge, pier, nonpropelled
BR	barge, refrigerated, nonpropelled
BRI	barge, refrigerated, inland waterways, nonpropelled
BRO	barge, oil
BSP	barge, self-propelled
BSPI	barge, self-propelled, inland waterways
BT	barge, training, nonpropelled
F	fireboat
FB	ferryboat
FD	drydock, floating
FMS	repair shop, floating, marine repair, nonpropelled
FS	freight and supply vessel, large (140 feet and over)
FSM	freight and supply vessel, medium (100 feet through 139 feet)

5-17. Vessel Deadweight Scale

a. Purpose. The vessel deadweight scale (fig. 5-17) is designed to furnish vessel tonnages and the effects of these tonnages on the mean draft of the vessel.

(1) Column A represents the number of long tons that may be carried in the vessel including fuel, stores, water, dunnage, and cargo, or any material that may be placed in the vessel, excluding equipment and machinery necessary for operation of the vessel.

(2) Column B represents the vessel's mean draft in feet and inches. This scale is graduated from the least possible draft of 8 feet to a maximum draft of 29 feet.

(3) Column C (displacement tonnage in salt water) represents the weight of the ship plus any material in or on the vessel.

(4) Column D (tons per inch immersion) denotes the number of long tons required to lower the vessel 1 inch with any given draft.

b. Use. The deadweight scale is used by the cargo planner to determine the long tons that may be placed in a vessel to reach the required draft. For example, a vessel loaded with 9,000 long tons will have a mean draft of 25 feet 4½ inches at the beginning of the voyage and, using 50 long tons of fuel, stores, and water per day at sea, will have used 500 long tons through a period of 10 days, thus reducing the mean draft to 24 feet 6 inches. From these figures, the cargo planner can determine the vessel's draft at the completion of the trip, and he will know whether the draft is correct for the type of harbor where the cargo will be discharged.

c. Cargo Deadweight Tonnage.

(1) In the deadweight column of the scale, the figure 0 is listed directly opposite the light ship weight. The figures above 0 indicate weight added to the vessel in the form of fuel, stores, and cargo. All weight placed in the vessel increases the ship's mean draft and, by adding 10,805 long tons to the light ship, the vessel is forced down in the water to a maximum mean draft of 28 feet 6¾ inches for sailing in summer salt water.

(2) Certain complications may be involved in determining the cargo deadweight tonnage of the vessel. For instance, the ship may have a fixed ballast that is not entered in the deadweight scale. In such an event, the ship's officers add this to the number of tons of fuel, stores, and water that are on board. Also, they note the location of the ballast in the ship. This must be deducted from the deadweight tonnage, together with the fuel, stores, and water to give a correct cargo deadweight tonnage. When the vessel is at a mean

draft of 28 feet 6 $\frac{3}{4}$ inches, summer salt water, it is in a condition known as displacement loaded, and, should weight in excess of 10,805 long tons be loaded in a light ship, it would be forced down in the water below the legal loadline for summer zone and would not be allowed to sail.

(3) To prevent overloading the vessel, the weight of the fuel, stores, dunnage, and water should be determined and deducted from the vessel deadweight tonnage to determine the maximum number of tons of cargo that may be placed in the vessel to bring it down to its marks.

Section III. TERMINAL AND WATER TRANSPORT OPERATIONS

5-18. Elements of Terminal Planning

a. In the planning data for terminal and related water transport operations, the basic period of time is a 20-hour working day. This is generally considered a complete round-the-clock working day for terminal operations; it is based on two 10-hour shifts. The remainder of the day is taken up in mealtime and shift changes. In forward areas, where enemy action may cause additional delays, 15 hours per day should be used as a planning figure. For general planning purposes, a transportation terminal service company (TOE 55-117) or its equivalent is considered capable of discharging 720 short tons per 20-hour working day. See also paragraph 5-22.

b. The three elements normally considered in terminal planning are—

(1) Estimation of the existing terminal capacity or the total tonnage and personnel that can be received, processed, and cleared through the terminal in a day.

(2) Determination of the terminal workload required to support the particular operation, expressed as target cargo tonnage and number of personnel per day.

(3) Estimation of base development requirements necessary to increase the terminal capacity to meet the target tonnage, including requirements for construction, equipment, and personnel.

5-19. Terminal Capacity

a. Terminal throughout capacity is determined by three major factors. In all instances, one of these is the limiting and thereby the determining factor. For planning purposes, each of the three factors may be expressed in terms of short tons per day. All three factors should be accurately estimated even though the limiting factor may be obvious. These estimates indicate the facilities where improvement effort will yield the greatest return in terms of tonnage-movement capability. The three major factors are—

(1) Terminal reception capacity: the number and type of ships that can be moved into the harbor or coastal area of the terminal per day.

(2) Terminal discharge capacity: the number of tons of cargo and personnel that can be discharged in the terminal per day.

(3) Terminal clearance capacity: the amount of cargo and personnel that can be moved through and out of the terminal per day.

b. A checklist for terminal capacity estimation is given below. Further information and procedures for estimating terminal capacity are provided in FM 55-8, FM 55-51, and FM 101-10.

Terminal Capacity Estimation Checklist.

Collect these data:

Compute these factors:

To determine:

Channel depths		
Obstructions		
Enemy air activity		
Enemy surface activity	(1) Evaluate to determine	
Enemy submarine activity	water terminal re-	
Climate and seasons	ception capacity.	
Weather and the characteristics		
Minefields or contaminated areas		
Capabilities in combating obstacles		
Tactical dispersion requirements		
Wharf facilities		
Beach capabilities		
Discharge rates ashore		
Discharge rates in the stream		
Anchorage area		
Extent of destruction or contamination	(2) Evaluate to determine	Water terminal through
Climate and seasons	water terminal dis-	put capacity.
Weather and tide characteristics	charge (input)	
Cargo-handling equipment available	capacity.	
Floating craft and equipment available		
Transit sheds and areas		
Availability of local labor		
Space reserved for local economy		
Enemy activity		
Capability of rail facilities		
Capacity of highway facilities	(3) Evaluate to determine	
Capacity of inland waterway facilities	water terminal	
Capacity of pipeline facilities	clearance (output)	
Capacity of air facilities	capacity.	
Enemy activity		

5-20. Determination of Terminal Workload

The terminal workload is assigned by the theater commander and is the mission of a particular terminal. The mission assignment is a target tonnage based on the terminal's throughput capacity. Target tonnage consists of initial and anticipated tonnages. Initial tonnage is the amount of cargo the terminal organization is expected to handle before its capability is increased by base development. Anticipated tonnage is the amount of cargo required at a future specified date to support a particular operation and to build up a reserve supply for the support of future operations. When the target tonnage assignment is made, the terminal commander makes an estimate of the construction, equipment, and personnel required to increase the terminal capacity to handle the anticipated tonnage. The actual capability of the terminal is dependent upon its sustained ability to receive and clear the daily capacity over a period of time.

5-21. Wharf Facilities and Anchorage Areas

a. General. Terminal discharge capacity is the 1-day capacity of a terminal to accommodate ships in the harbor, to discharge them, and to clear the terminal of cargo. Considerations must include the harbor berths and anchorage areas available, wharf capacity, lighterage discharge, and local conditions. For general planning purposes, two methods of ship discharge are—discharge directly onto the wharf from vessels berthed alongside; and discharge by lighterage from vessels anchored in the stream. Deep-draft wharfage must be provided wherever alongside discharge is contemplated, while shallow-draft wharfage and anchorage areas must be given joint consideration when lighter discharge is contemplated.

b. Berths and Anchorages. The first fact that must be determined is whether vessels can be brought into the anchorage areas and alongside the wharves. Berths and anchorages are evaluated according to the size of vessels they can accommodate.

(1) *Classification of alongside berths.*

	General				Tanker				
	Berth dimensions				Class	Berth dimensions			
	Length		Depth			Length		Depth	
	Feet	Meters	Feet	Meters		Feet	Meters	Feet	Meters
A	565	172	31-30	9.4-9.1	T-A	600	183	34	10.4
B	460	140	29-23	8.8-7.0	T-B	525	160	31	9.4
C	350	107	22-18	6.7-5.5	T-C	450	137	26	7.9
D	250	76	17	5.2	T-D	250	76	14	4.3
E	200	61	13	4.0					
F	100	30	7	2.1					

(2) *Anchorage berths.*

(a) *Anchorage berth diameter formulas.* The following formula is used to find the diameter for anchorage berths:

$$\frac{2(7D + 2L)}{3} = \text{diameter in yards}$$

where

D = depth of water in feet

L = length of vessel in feet

Note 1. Diameter in yards $\times 0.9144$ = diameter in meters.

Note 2: Bottom characteristics, landmarks, and underwater obstacles must be taken into consideration when selecting an anchorage site.

(b) *Classification of anchorage berths.*

Class	Yards	Diameter		Depth of water		Type of vessel
		Meters	Feet	Meters		
I	Over 800	Over 732	Over 38	Over 12		Large naval or a commercial passenger ship.
II	800-500	732-457	38-30	12-9		Standard oceangoing vessel.
III	500-300	457-274	30-20	9-6		Destroyer or small cargo vessel.

c. *Wharf Capacity.* Terminal capacity estimates are based on the use of all available wharf facilities. All facilities suitable for handling general cargo should be included in the estimate—for example, open or covered terminals, naval wharves, ship-repair and fitting-out wharves, bulk-cargo wharves, and special-purpose wharves. If the use of a particular wharf is doubtful and its capacity has been included in the estimate, a clarification should be given. Wharf capacity is materially affected by the factors discussed below.

(1) *Type.* The type of wharf must be considered by the analyst. The general term "wharf" includes both quays and piers. A quay is a wharf parallel with the shoreline of a basin or harbor with water and accommodations for ships on one side only. A pier is a wharf which projects into the harbor or basin

with water and accommodations for ships on both sides. There are several kinds of piers, such as T-head, L-head, and marginal.

(2) *Layout.* The analyst must also consider the layout of the facility. This includes adequacy of approaches, stacking space on the landward side, raised or depressed tracks, curbs, fences, deck surfacing material, transit-shed space, number and size of transit-shed doors, and the depth of high and low water alongside.

(3) *Weather.* Weather, particularly during extreme conditions, has a direct bearing on the use of estimated capacity of a wharf.

(4) *Alinement.* The alinement of the face of the wharf is an important factor. The angle points and curvatures along the wharf face must be considered. If they are excessive, the

usable linear footage must be reduced appropriately.

(5) *Deck.*

(a) *Load capacity.* The load capacities of the wharf deck and of the transit shed floor are of prime importance. A rule-of-thumb method for determining the adequacy of the load capacity is the present use of the wharf. If it is known that a certain cargo is normally handled, a fair load-capacity evaluation may be made.

(b) *Height.* The height of the wharf deck must be considered in relation to the tidal rise. Generally, a wharf should be at least 5 feet (1.5 meters) above high-tide level.

(c) *Working space.* The working space is determined by the type of wharf, the length and width of the wharf apron, the wharf's decking, and its exits. The working space must be wide enough to allow general cargo to be unloaded and cleared without undue delay. Dimensions shown below can be used in planning. Local customs, specialized wharves, and unusual construction may permit variations in these figures.

1. *Wharf length.* For planning purposes, 100 feet (30 meters) of wharf is required for each hatch or each lighter to be discharged. The discharge rate (para 5-22) for ships and coasters is reduced 20 to 25 percent for each 100-foot reduction in wharf length under the minimum required. In determining lighterage facilities, length more than 100 feet but less than the next 100-foot unit is disregarded. For example, a 150-foot (45-meter) wharf accommodates only one lighter; a 250-foot (75-meter) wharf accommodates two lighters, etc.

2. *Wharf width.* A wharf working area of at least 60 feet (18 meters) is necessary for proper cargo handling and shipside clearance when discharging from only one side of a wharf. When both sides of a wharf are used simultaneously, each side should have a 45-foot (14-meter) working space.

(d) *Depth alongside.* Fluctuations in tide levels affect the discharge of cargo, especially where tidal variation is great and ships need the advantage of high tides to

reach their berths. If the wharves are not located in wet docks and if the tidal variations are extreme, the discharge-capacity estimate should be adjusted to reflect this condition. The effective terminal discharge capacity may be reduced as much as 50 percent if alongside depths are reduced below the operable minimum by the tidal range. Under normal conditions, the water should be at least 30 feet (9 meters) deep at low tide. (A minimum of 30 feet is used for planning purposes because this depth accommodates virtually all deep-draft dry-cargo vessels.)

(e) *Physical condition.* Physical condition must be considered when the usefulness of a wharf is evaluated, for deterioration or damage may limit its capacity.

d. *Lighterage Discharge.* Wharves used by lighters should be within a reasonable distance of a sufficient number of anchorages and moorings. Lighterage berths are assigned in units of 100 feet (30 meters) for each lighter (taken to the nearest 100 feet). The unit measurement must be used realistically—length of wharf more than 100 feet but less than the next 100-foot unit is disregarded (a 350-foot (107-meter) wharf accommodates three lighters at the same time). All alongside berths with depths of less than 18 feet (5.5 meters) are considered lighter berths.

e. *Local Conditions.* Conditions may vary with localities and sometimes may be very unusual. When necessary, berth, wharf, and lighter discharge factors must be adjusted or reduced to meet emergencies imposed by local conditions.

5-22. Discharge Rates

a. *Commercial-Type Loading.* For planning purposes, the average ship is considered to be 500 feet long and 60 feet wide with five hatches, the average coaster 350 feet long and 35 feet wide with four hatches, and the average lighter 100 feet long and 35 feet wide. This excludes landing craft and amphibians. The figures given below for ships and coasters in the steam indicate tonnage discharged from the ship or coaster into lighters. The limiting factors are the number of lighters available

and the wharf space provided for their discharge. Number of lighters required is based upon the number of hatches, the size of the lighters, and the turnaround time. The following discharge rates are based on average sizes of the type of vessels indicated.

(1) Average ship, alongside or in stream—720 short tons or 643 long tons per 20-hour day.

(2) Average coaster, alongside or in stream—500 short tons or 446 long tons per 20-hour day.

(3) Average lighter alongside wharf—180 short tons or 160 long tons per 20-hour day.

b. Specialized Loading. When maximum unloading efficiency is the governing factor rather than economy of cargo space, the principles of combat loading should be employed. For this specialized loading, mixture of cargo types within ships' holds should be kept to a minimum, and each hatch must be self-sustaining.

(1) Stowage of cargo should be blocked vertically in each hatch; this saves time by reducing the number of times the cargo gear must be rerigged or shifted. Within each cargo space, drafts of cargo should be palletized, netted, or containerized; they should not be tiered unless MHE is available to move cargo from the wings to the hatch square. When cargo is palletized, at least four pallets in each hatch square should have birdles intact so that no time will be wasted in breaking the stowage.

(2) Vehicles should not be floored over and tiered, even if space is available, as bulling vehicles to the square on the upper tier and clearing the flooring and shoring is time consuming. So far as possible, trailers should be stowed with their prime movers. Unit cargo may be loaded in vehicles to the lowest reducible height if the cargo-gear capacity is not exceeded. Powered vehicles must be in running condition with fuel tanks three-quarters full.

(3) Unloading time for each hatch is computed at time of prestowage, using a profile loading diagram (fig. 5-18) for the ship. The

profile loading diagram may be filled out from the information in the storage plan. Time factors for hatch opening, shift of gear, and all drafts are added to obtain the total unloading time for each hatch. This total is entered in the tabulation for the hatch on the profile loading diagram.

(4) Rig and boom capacities differ among hatches for each design of cargo vessel. In general, 5-ton booms are installed to serve each hatch and one or more hatches are also served by jumbo booms of from 30- to 60-ton capacity. The limiting load factor of the rig is the safe working load of the wire rope multiplied by the number of parts. The normal safe load for a single-rigged yard-and-stay rig is 6,600 lb for $\frac{5}{8}$ " wire and 8,000 lb for $\frac{3}{4}$ " wire (improved plow steel) in good condition. Heavier weights must be lifted by doubled yard-and-stay rigs, swinging booms, four-boom rigs, or jumbo booms.

(5) Average weights of drafts:

(a) Palletized general cargo—1 STON

(b) Palletized ammunition— $1\frac{1}{2}$ STON

(c) CONEX—5 STON

(d) Vehicle weights depend upon type and preloading.

(6) Unloading time can be computed by using the following factors as guidance:

(a) Single-rigged yard-and-stay, 5 minutes per draft (pallets, $\frac{1}{4}$ -ton trucks and trailers, $1\frac{1}{2}$ -ton trailers, empty $\frac{3}{4}$ -ton trucks).

(b) Doubled yard-and-stay, or double-purchase swinging-boom rig, 10 minutes per draft (CONEX, empty $2\frac{1}{2}$ -ton truck).

(c) Jumbo-boom rig, 15 minutes per draft (vehicles heavier than $2\frac{1}{2}$ -ton truck, APC, tanks).

(d) To open hatch, 15 minutes average (25 minutes for weatherdeck hatch; 10 minutes for 'tween-deck hatch).

(e) To shift rig, 30 minutes.

(7) Unloading time estimates for specially equipped vessels, such as roll on/roll off and LPH equipped with special ramps, elevators, pallet conveyors, monorails, or other devices, must be developed from experience gained during loading or from records kept on the vessel.

- 1 MAIN DECK
- 2 SECOND DECK
- 3 FIRST PLATFORM
- 4 THIRDO PLATFORM
- 5 LOWER HOLD

U. S. S. FREMONT (APA 44)

- 1 FOC'SLE DECK
- 2 MAIN DECK
- 3 SECOND DECK
- 4 FIRST PLATFORM
- 5 SECOND PLATFORM
- 6 THIRDO PLATFORM
- 7 LOWER HOLD

CARGO STOWED IN TROOP
BERTHING SPACE
BAGGAGE 78,980
COMBAT 2,446
OFFICE 5,200
TOTAL 86,626

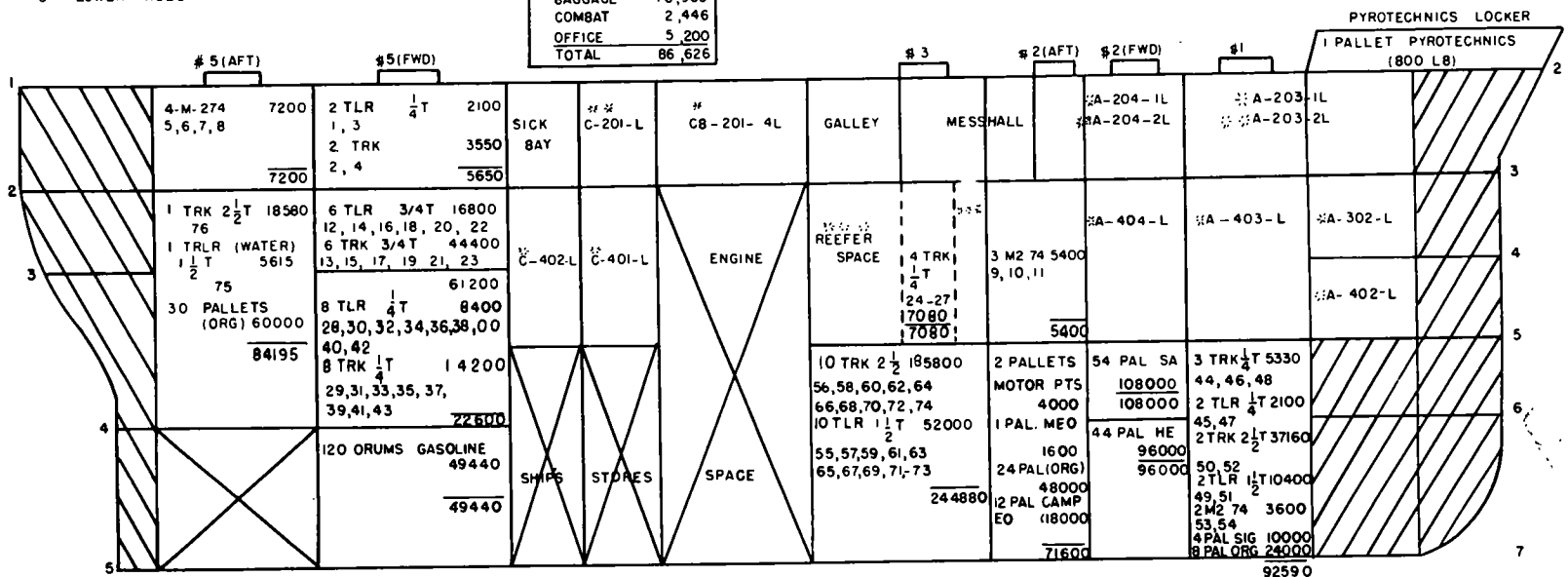


Figure 5-18. Profile loading diagram.

(8) Detailed guidance on combat loading, commodity loading, and selective loading is contained in FM 60-30. Loading diagrams for U.S. Navy Amphibious Force vessels, as well as standard maritime commission design vessels should be secured from the combat cargo officer assigned to an individual vessel. It will be found that while these vessels may be of the same design, their loading capacity for each hold will differ.

5-23. Temporary Storage Areas

To plan for temporary storage areas for cargo, use the figures given below.

a. Open Storage. Approximately 10,000 square feet of open storage area is required for each 560 short tons, or 500 long tons, or 1,000 measurement tons of cargo. Average stack height should be 6 feet.

b. Covered Storage. Approximately 8,000 square feet of covered storage area is required

for each 560 short tons, or 500 long tons, or 1,000 measurement tons of cargo. Average stack height should be 8 feet. Generally, 10 percent of 1 day's target tonnage will require covered storage.

5-24. Personnel and Equipment Requirements

For planning purposes, one terminal service company (TOE 55-117) or its equivalent in personnel and equipment is required for each ship berth in a water terminal or for each 720 short tons of the terminal's daily capacity. Paragraph 5-21 lists the factors for determining ship berth space.

5-25. Estimating Water-Terminal Capacity

The following example demonstrates the recommended procedure for estimating water-terminal capacity based upon the steps and data outlined in the preceding paragraphs and using the harbor chart shown in figure 5-19.

a. Wharf Facilities.

Wharf No.	Length		Width		Minimum depth alongside	
	Feet	Meters	Feet	Meters	Feet	Meters
1	1,060	323	80	24.4	32	9.8
2	490	150	60	18.3	30	9.2
3	580	177	90	17.4	30	9.2
4	535	163	100	30.5	34*	10.4*
5	125	38	54	16.5	8	2.4
6	295	90	60	18.3	15	4.6
7	450	137	75	22.9	22	6.7
8	210	64	60	18.3	16	4.9

*Each side.

b. Anchorage Areas.

(1) There is sufficient area inside the harbor to anchor three ships where they can be worked continuously.

(2) In good weather, two vessels can be anchored and worked outside the breakwater.

(3) Winds, swells, tides, and tidal currents present no unusual problems.

c. Discharge Tonnage.

(1) *At deep-draft wharfage.*

Wharf No.	Victory ship berths	Discharge rate (STON per day)
1	2	2 x 720 = 1,440
2	1	1 x 720 = 720
3	1	1 x 720 = 720
4	2	2 x 720 = 1,440
Total		4,320

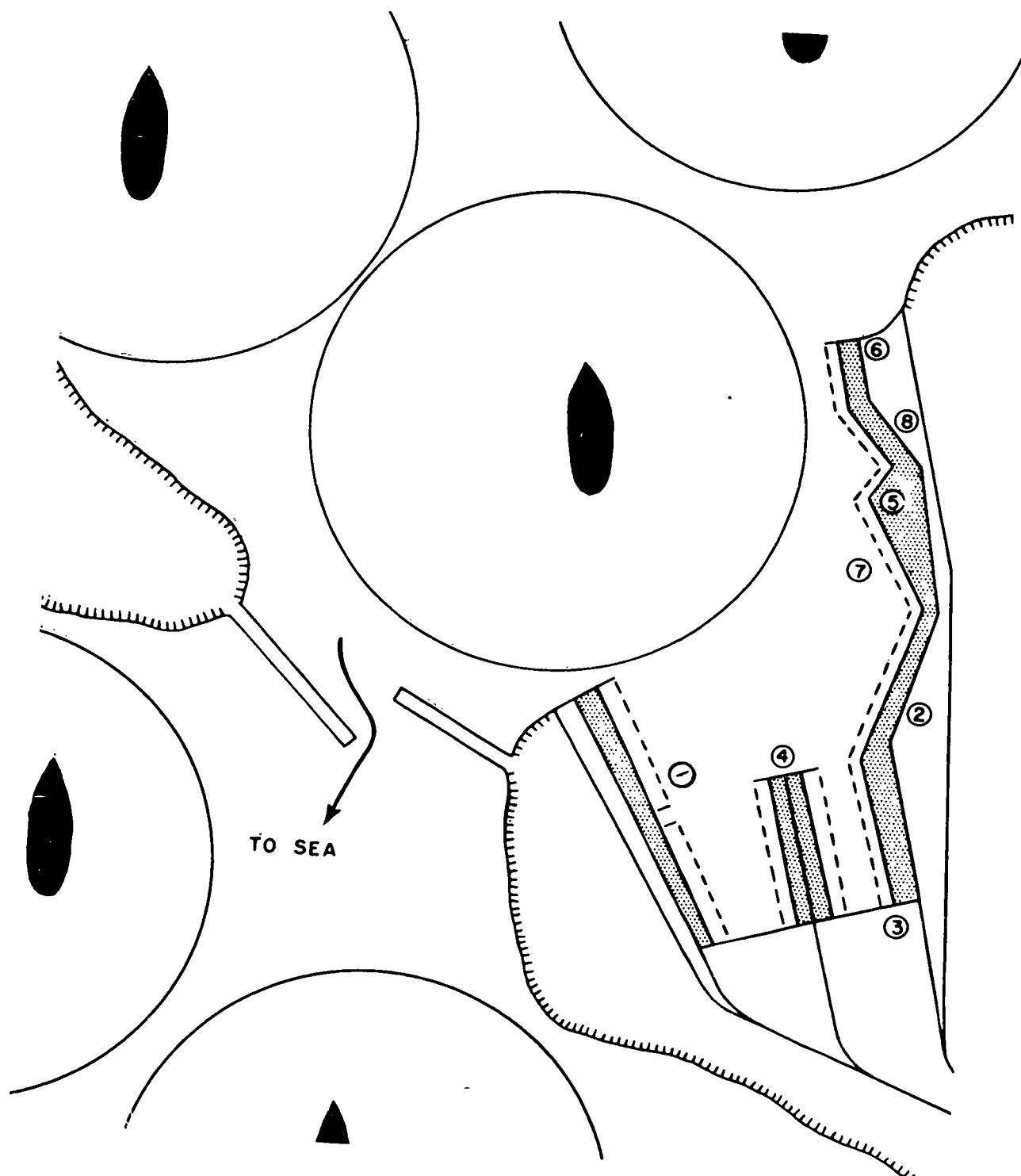


Figure 5-19. Harbor chart for terminal capacity estimation.

(2) *At lighterage wharves.*

Wharf No.	Lighter berths	Discharge rate (STON per day)
5	1	1 x 180 = 180
6	*3	3 x 180 = 540
7	4	4 x 180 = 720
8	2	2 x 180 = 360
Total	-----	1,800

*Wharf No. 6 is only 295 feet long. In paragraph 5-21, three lighters require 300 feet. However, the 5-foot shortage will not affect operations appreciably if three lighters are docked here.

(3) *Alternate method.* If only the total length of wharfage is known, this length in feet may be multiplied by 1.2 for alongside discharge and by 1.4 for lighterage discharge. The quantities thus obtained are conservative planning figures; they are expressed as long tons discharged per day.

d. *Rate of Discharge From Ships at Anchor to Lighters.* According to the chart, three ships can be anchored inside the breakwater, and two can be anchored and worked outside the breakwater in good weather. Therefore, in good weather, cargo can be discharged from ships to lighters at the rate of $(3 + 2) \times 720 = 3,600$ short tons per day.

e. *Summary of Daily Terminal Capacity.*

(1) Discharged alongside deep-draft wharves—4,320 short tons per day.

(2) Discharged from lighters to wharves—1,800 short tons per day.

(3) Transferred from ships to lighters—3,600 short tons per day.

(4) The maximum discharge per day is 1,800 short tons because lighter wharfage is the limiting factor (para 5-19a). Therefore, the total daily terminal capacity is 6,120 short tons: 4,320 short tons alongside; 1,800 short tons by lighter.

f. *Personnel and Equipment Requirements.* Personnel and equipment requirements to maintain the above daily tonnage figure may be determined by dividing 6,120 short tons by 720 short tons (daily terminal service company discharge capability). Therefore, nine terminal service companies (TOE 55-117) or their equivalent in personnel and equipment and the necessary lighterage support will be

required to maintain the discharge capacity of this terminal.

g. *Weather Considerations.* Advance study must be made to determine the probable effect of bad weather on the rate of discharge and other factors in water terminal capacity. Continuous records of daily discharge plotted against weather and surf conditions prove valuable in planning future discharge at the same and similar terminals.

5-26. *Inland Waterways Service*

a. The use of inland waterways for military purposes is normally envisaged only in underdeveloped areas in which alternate modes are either lacking or insufficient. These waterways are to be used principally for civilian traffic and for the restoration of the local economy. Further, it is assumed that rehabilitation of these waterways will be undertaken by local authorities and that a minimum of military effort will be diverted for the purpose, except where designated for immediate military use and equipment salvage. Inland waterways can be used to relieve the pressure on other modes of transportation; they are especially useful for moving nonperishable supplies.

b. When required, an inland-waterway service may be formed to control and operate a waterway system, to formulate and coordinate plans for using inland-waterway transport resources, and to provide for the integration and supervision of local civilian facilities used in support of military operations. This operational organization may vary in size from a single barge crew to a complete inland-waterway service, depending upon the requirements. It may be composed entirely of military personnel or may be manned by local civilians supervised by military units of the appropriate transportation staff section.

c. Although an inland-waterway service may be operated by a terminal command, a terminal battalion composed of appropriate terminal service, harbor craft, boat, and/or amphibian units will most often be employed in this capacity. A typical inland-waterway organization is shown in figure 5-20.

ORGANIZATION FOR TRANSPORTATION INLAND WATERWAYS SERVICE

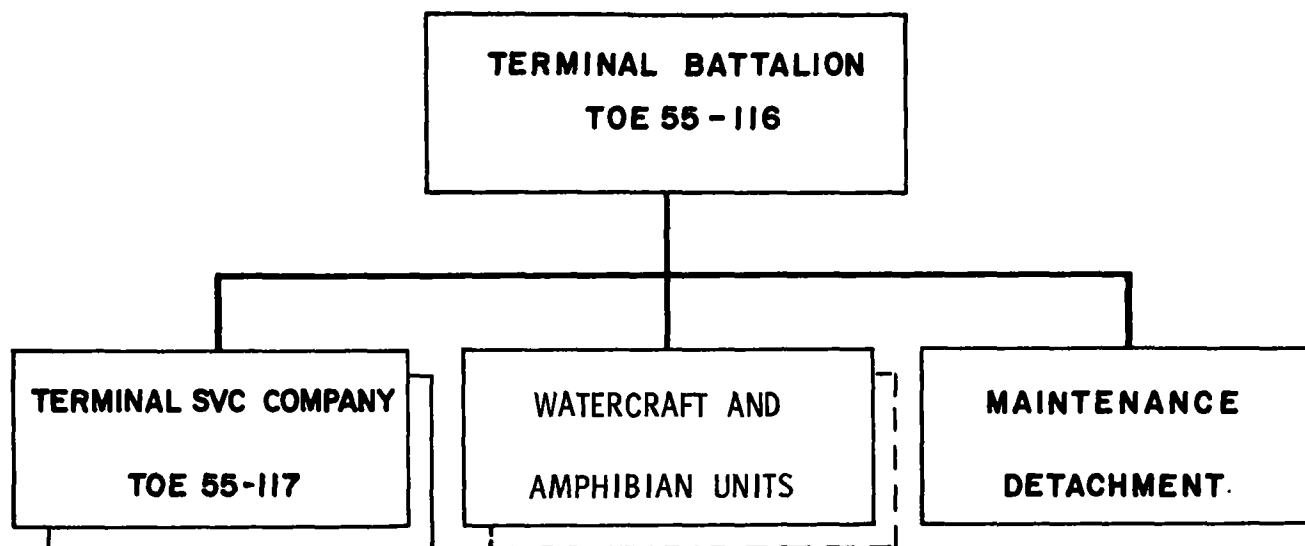


Figure 5-20. Organizational chart, transportation inland waterways service.

5-27. Characteristics Affecting Inland-waterway Capabilities

When determining the capability of an inland waterway, the following must be considered:

- a. Restricting widths and depths of channel.
- b. Vertical and horizontal bridge clearance.
- c. Location of dams and other bars to navigation.
- d. Location of locks, dimensions, and timing.
- e. Seasonal floods and droughts, their frequency and duration.
- f. Normal freezeup and opening dates.
- g. Hazards to navigation, such as rapids and falls.
- h. Speed and fluctuation of current.
- i. Waterway maintenance requirements.
- j. Changes of channel.

5-28. Waterway Capacity Estimates

a. *Limiting Factors.* Factors, other than waterway characteristics, which limit waterway capacity are—

(1) Availability of suitable barges or craft.

(2) Availability of suitable operating personnel.

(3) Availability and adequacy of terminals and terminal facilities.

b. *Turnaround Time.* This factor is defined as the time required for a barge or craft to load, travel to destination, unload, return to origin, and be ready to resume loading. It has considerable effect on waterway capacity and involves:

(1) Length of haul, taken as round trip distance.

(2) Speed in still water—4 miles per hour (3.4 knots or 6.43 Kmph).

(3) Speed and direction of current.

(4) Loading and unloading time—computed at 8.4 short tons per barge per hour.

(5) Time consumed in locks.

(6) Operating hours per day—normally taken as 20, allocating the remaining 4 for maintenance, refueling, restoring, etc.

c. *Capacity Determination, Craft Available to Fill or Exceed Waterway Capacity.* When

sufficient barges or craft are available to fill or exceed waterway capacity, the daily tonnage that may be moved over the waterway is equal to one-half the number of craft per day that can be passed through the most limiting constriction (for example, a lock, lift bridge, narrow channel, etc.) times the average net capability of the craft in use.

d. Capacity Determination, Craft Not Available to Fill or Exceed Waterway Capacity. The following formula may be used to determine the number of tons a given number of barges can transport a given distance daily:

$$\frac{\text{Number of barges} \times \text{tons per barge} \times \text{hours of operation per day}}{\text{Turnaround time in hours}} = \text{Tons moved daily}$$

Example: Determine the daily tonnage 20 barges of 270 short tons capacity each can move 60 miles forward with no lost time in locks and negligible effect due to current.

$$\text{Travel time per barge} = \frac{2 \times 60}{4} = 30 \text{ hours}$$

$$\text{Loading and unloading time per barge} = \frac{2 \times 270}{8.4} = 64.3 \text{ hours}$$

$$\text{Turnaround time per barge} = 30 + 64.3 = 94.3 \text{ hours}$$

$$\frac{20 \text{ barges} \times 270 \text{ tons per barge} \times 20 \text{ hours daily availability}}{94.3 \text{ hours turnaround time}} = 1,145.3 \text{ short tons daily}$$

5-29. Floating Craft Requirements

a. Cargo Craft. To determine the number of barges or cargo craft required to move a given tonnage a given distance forward daily, use the following formula:

$$\frac{\text{Daily tonnage} \times \text{hours turnaround time}}{\text{Tons per barge} \times \text{hours of operation daily}} = \text{Number of barges required.}$$

Example: Determine the number of barges having a capacity of 500 short tons required to move 1,000 short tons daily a distance of 100 miles forward, assuming no lost time in locks and negligible effect due to current.

$$\text{Travel time per barge} = \frac{100 + 100}{4} = 50 \text{ hours}$$

$$\text{Loading and unloading time per barge} = \frac{2 \times 500}{8.4} = 119 \text{ hours}$$

$$\text{Turnaround time per barge} = 50 + 119 = 169 \text{ hours}$$

$$\frac{1,000 \text{ tons daily} \times 169 \text{ hours turnaround time}}{500 \text{ tons per barge} \times 20 \text{ hours daily operation}} = 16.9 \text{ barges} = 17 \text{ barges required.}$$

b. Tugs and Towboats. Since a single tug or towboat can normally be used to tow more than one barge and since loading time is not a consideration in tug or towboat availability, it follows that fewer tugs than barges will be required in any given situation. To determine the number of tugs or towboats required to efficiently operate a given number of barges in a given situation, use the following formula:

$$\frac{\text{Total number of barges} \times \text{turnaround time for tugs in days}}{\text{Number of barges per tow} \times \text{turnaround time for barges in days}} = \text{Number of tugs}$$

Example: Determine the number of tugs required to operate 400 barges, when each tow consists of 5 barges, turnaround time for barges is 4 days, and turnaround time for tugs is 2 days.

$$\frac{400 \text{ barges} \times 2 \text{ days tug turnaround}}{5 \text{ barges per tow} \times 4 \text{ days barge turnaround}} = 40 \text{ tugs required.}$$

c. Adequacy of Terminal Facilities. Port facilities include berthing space and cargo handling equipment. Generally, lack of terminal facilities does not restrict inland waterway movement, for usually temporary berthing facilities can be constructed. Without mechanical handling facilities, general cargo can be handled at the rate of 10 tons per hour per barge. With forklifts, at least 30 tons per hour per barge can be handled. Nevertheless, when existing port facilities are inadequate and additional facilities cannot be improvised, the existing port facilities may be the most restrictive factor in the entire movement. In such a case, the capacity of port facilities determines the inland-waterway movement capability. This problem cannot be solved by using formulas; its solution requires careful analysis and sound judgment.

5-30. Inland Terminal Capacity

Checklist for estimation of inland terminal throughput capacity.*

<i>Collect these data:</i>	<i>Compute these factors:</i>	<i>To determine:</i>
Channel depths	(1) Evaluate to determine inland terminal reception capacity.	Inland terminal throughput capacity.
Obstructions		
Capacity of rail facilities		
Capacity of highway facilities		
Capacity of pipeline facilities		
Capacity of air facilities		
Enemy air activity		
Enemy surface activity		
Climate and seasons		
Weather and tide characteristics		
Contaminated areas	(2) Evaluate to determine inland terminal discharge (input) capacity.	
Capabilities in combating obstacles		
Tactical dispersion requirements		
Wharf and/or platform facilities		
Discharge rates		
Unloading rates		
Loading rates		
Extent of destruction or contamination		
Climate and seasons		
Weather and tide characteristics		
Materials-handling equipment available	(3) Evaluate to determine inland terminal clearance (output) capacity.	
Cargo-handling equipment available		
Floating craft and equipment available		
Airfield capabilities		
Transit sheds, yards, and areas		
Local labor available		
Space reserved for local economy		
Capacity of rail facilities	(3) Evaluate to determine inland terminal clearance (output) capacity.	
Capacity of highway facilities		
Capacity of inland-waterway facilities		
Capacity of pipeline facilities		
Capacity of air facilities		

*Capacity in tons for one 20-hour working day.

5-31. The United States Inland-Waterway System

a. General. Practically all of the navigable inland waterways of the United States are either on or east of the Mississippi River. Those west of the Mississippi are along the Texas gulf coast, the Missouri River, Sacramento River in California, Columbia River in Oregon, and Puget Sound in Washington. The inland waterways support approximately 8 percent of the total freight moved commercially in the United States. Of the approximately 50,000 persons employed, about two-thirds are vessel personnel. Excluding the Great Lakes system, the inland-waterway service uses over 5,000 propelled and 14,000 nonpropelled vessels. Typical cargo carried on these waterways is shown below.

<i>Type of cargo</i>	<i>Percent of total cargo</i>
Seashells	5.27
Animal products (inedible)	.22
Grain and grain products	1.34
Coffee, raw or green	.04
Sugar	.23
Molasses	.23
Soybeans	.32
Logs	5.35
Lumber and lumber products	.49
Pulpwood	.48
Woodpulp	.10
Paper and paper products	.31
Anthracite coal	.30
Bituminous coal and lignite	25.00
Coke	.14
POL	34.50
Building cement	.48
Clays and earths	.51
Sulphur	.72

<i>Type of cargo</i>	<i>Percent of total cargo</i>
Limestone -----	.81
Salt -----	.09
Sand, gravel, crushed rock -----	13.30
Iron and steel -----	2.43
Aluminum ores and scrap -----	.05
Copper ores and scrap -----	.09
Construction and mining machinery -----	.09

<i>Type of cargo</i>	<i>Percent of total cargo</i>
Motor vehicles and parts -----	.13
Coal tar products -----	.35
Sulphuric acid -----	.47
Industrial chemicals -----	.74
Fertilizer -----	.18
Chemical products, miscellaneous -----	.01
Miscellaneous -----	5.23

b. *Depths, Navigable Distances, and Average Freight for Principal Waterways.*¹

Controlling low-water depths (ft)	Mississippi River system	Atlantic Coast rivers	Pacific Coast rivers	Gulf Coast rivers ²	Rivers emptying into Great Lakes	Federal canals and connecting channels	State and private canals	Gulf intra-coastal (Appalachian Bay, Fla., to Mexican border)	Florida west coast	Atlantic intra-coastal (Norfolk, Va., to Key West, Fla.)	Miscellaneous
Navigable Statute Miles and Kilometers ³											
Less than 3 -----	3,626 (5,840)	1,125 (1,810)	757 (1,220)	1,328 (2,140)							
3-6 -----	2,297 (3,700)	1,340 (2,160)	540 (860)	1,343 (2,160)	-----	500 (805)	-----	-----	-----	-----	800 (1,288)
6-9 -----	1,988 (3,200)	900 (1,450)	555 (893)	968 (1,560)	-----	1,077 (1,735)	-----	-----	103 (166)	562 (904)	
9-12 -----	4,612 (7,410)	539 (868)	98 (158)	634 (1,020)	17 (27.4)	801 (1,289)	171 (276)	-----	-----	18 (29)	
Over 12 -----	249 (401)	1,805 (2,900)	248 (400)	24 (38.6)	121 (195)	710 (1,140)	525 (845)	1,116 (1,795)	-----	1,398 (2,250)	
Freight											
Average annual short-ton miles (in millions) -----	45,780	2,146	1,961	636	-----	15,074	12	27	-----	4	

¹ Great Lakes not included.

² Mississippi River not included.

³ Quantities in parentheses represent kilometers.

c. *Important Waterways, Terminals, Critical Distances, Depths, and Cargo.* The table below gives general planning information for inland-waterway transportation in the United States. Some of the important waterways and terminals are shown, and typical commercial cargo is included since this could be of interest to a strategic planner. When a move on an inland waterway is contemplated, the planner should obtain a large-scale hydrographic map and plan the move in detail.

Name of waterway	Principal terminals	Critical distances	Controlling depths for specified locations	Typical cargo carried commercially
Allegheny River -----	Pittsburgh, Pa., New Kensington, Pa., Kittanning, Pa., East Brady, Pa.	325 miles (523 km) from its rise in northern Pennsylvania to its mouth at Pittsburgh where it joins the Monongahela River to form the Ohio River. The Allegheny River consists of two sections: the improved portion (locks and dams), Pittsburgh, to above East Brady, Pa., 72 miles (116 km); and the open channel (unimproved) portion above East Brady, Pa.	9 feet for improved portion, Pittsburgh, to above East Brady, 72 miles (116 km); no specific depths for open channel portion (unimproved) above East Brady.	Coal, coke, sand, gravel, POL and POL products, glass, furnace slag, lignite crushed rock, nonmetallic minerals and products, iron and steel, iron ore, industrial chemicals.

Name of waterway
Atlantic intracoastal
waterway.

Principal terminals
Norfolk, Va., Elizabeth
City, N.C., Washington,
N.C., Wilmington, N.C.,
Georgetown, S.C.,
Charleston, S.C., Savan-
nah, Ga., Jacksonville,
Fla., Palatka, Fla.,
Sanford, Fla., St.
Augustine, Fla.,
Daytona Beach, Fla.,
West Palm Beach,
Fla., Miami Beach, Fla.

Critical distances
The main route extends 1,262
miles (2,300 km) from
Norfolk to Key West, Fla.,
with a 65-mile (104.5 km)
alternate channel, known
as the Dismal Swamp
Canal Route (west of, and
generally parallel to, the
main route) extending
south from Norfolk,
through the Southern
Branch of Elizabeth River,
Deep Creek, Dismal Swamp
Canal, Turners Cut, and
Pasquotank River to its
junction with the main
route at the mouth of the
Pasquotank River on Albe-
marle Sound, N.C.

*Controlling depths
for specified
locations*

(1) *Main route*: 12 feet from
Norfolk, to the Va.-N.C.
state line, 27 miles (43.3
km); 10 feet from Va.-N.C.
line to Little River, S.C.,
at N.C.-S.C. state line, 308
miles (496 km); 10 feet
from Little River to Port
Royal Sound, S.C. (near
Beaufort), 210 miles (338
km); 9 feet from Port
Royal Sound, to Fernan-
dina, Fla. (Cumberland
Sound), 165 miles (266
km); 12 feet from Fernan-
dina to St. John River, Fla.
(Jacksonville), 22 miles
35.4 km); 12 feet from
Jacksonville to Eau Gallie,
Fla., 198 miles (319 km),
except for several shoals
with limiting depth of 7.8
feet; 8 feet from Eau
Gallie to Miami, 174 miles
(280 km); 6.5 feet from
Miami, to Cross Bank, Fla.,
64 miles (103 km); 5 feet
from Cross Bank to Key
West, Fla., 94 miles (151
km).

(2) *Dismal Swamp Canal
route*: 8.6 feet in Deep
Creek, Va., 3 miles (4.83
km); 6.7 feet in Dismal
Swamp Canal, Va. and
N.C., 22 miles (35.4 km);
9.2 feet in Turners Cut,
N.C., 5 miles (8.05 km);
and 9.4 feet in Pasquotank
River, N.C., 35 miles (56.4
km).

9 feet from Mobile to Mile
444.6 on Mulberry Fork,
Mile 447.6 on Sipsey Fork,
and Mile 420.6 on Locust

*Typical cargo
carried
commercially*

Logs, paper, pulp, sand,
gravel, fish, POL and POL
products, fertilizer, pulp,
acid phosphate, paperboard
and pulpboard, seafood,
seashells, automobiles,
grain and grain products,
sugar, soybeans, limestone,
salt, iron and steel, indus-
trial chemicals.

Black Warrior, War-
rior, and Tombigbee
River System.

Birmingham, Ala.,
Tuscaloosa, Ala.,
Demopolis, Ala.,
Mobile, Ala.

The Black Warrior and
Warrior Rivers, a single
stream, rise in northern
Alabama above Birming-

Iron ore, manganese ore,
sulphur, coal, POL and
POL products, clay and
bentonite, logs, stone and

		ham and unite with the Tombigbee River at Demopolis. From there the Tombigbee flows south, uniting with the Alabama River to form Mobile River 45 miles (72.4 km) above the head of Mobile Bay. The distance by water from Mobile to the vicinity of Birmingham is about 415 miles (668 km).	Fork of the Black Warrior River.	rock, pulpwood, iron and steel articles, cast iron pipe and fittings, seashells, molasses, lignite, cement, limestone, sand, gravel, iron ore concentrates, non-ferrous metals and scrap, industrial chemicals.
Calumet-Sag Channel	Blue Island, Ill -----	23.8 miles (38.3 km) from its junction with the Chicago Sanitary and Ship Canal to Blue Island, the Little Calumet Rivers to Turning Basin No. 5.	9 feet for entire length ----	Grain and grain products, soybeans, coal and lignite, POL and POL products, sulphur, sand, gravel, crushed rock, iron and steel, manganese, iron ore.
Chesapeake Bay system (James, York, Rappahannock, and Potomac Rivers)	Norfolk, Va., Newport News, Va., Richmond, Va., Fredericksburg, Va., Washington, D.C., Baltimore, Md., Cumberland, Md.	-----	-----	Logs, paper pulp, POL, fish, fertilizer, seashells, seafood, phosphate, pulpwood, automobiles, coal, coke, sand, gravel, sugar, lumber and shingles, lignite, sulphur, nonmetallic minerals, iron and steel, sulphuric acid, industrial chemicals, paper and paper products, naval stores.
Columbia River -----	Astoria, Ore., Vancouver, Wash., Portland, Ore., The Dalles, Ore., Kennewick, Wash., Rickland, Wash.	Mouth to Canadian border, 745 miles (1,200 km).	33 feet or deeper between mouth of Columbia River and mouth of Willamette River (Mile 101.5); 30 feet to Interstate Bridge, Vancouver, Wash. (Mile 106.5); 15 feet from Vancouver to Bonneville, Ore. (Mile 145.3); 24.2 feet over miter sills at Bonneville Lock and Dam; 20 feet from Bonneville to The Dalles-Celilo Canal (Mile 191); 7 feet through The Dalles-Celilo Canal; 7 feet from Celilo, Ore. (Mile 201) to McNary	Grain and grain products, coal tar products, vegetables and fruits, sawmill products, sand and gravel, coal, seafood, stone and rock, POL and POL products, sulphur, logs, hogged fuel, lumber, shingles and lath, iron and steel articles, iron and steel pipe and fittings, woodpulp, newsprint paper, printing paper, paper and paper products, wrapping paper, canned foods, cement, salt, crushed rock, chemicals and chemical products.

<i>Name of waterway</i>	<i>Principal terminals</i>	<i>Critical distances</i>	<i>Controlling depths for specified locations</i>	<i>Typical cargo carried commercially</i>
Cumberland River ----	Burnside, Ky., Celina, Tenn., Nashville, Tenn., Eddyville, Ky.	693 miles (1,115 km) from junction of Poor and Clover Forks in Harlan County, Ky., to the mouth near Smithland, Ky., on the Ohio River; 55 miles (88.5 km) from Wolf Creek Dam to Burnside, Ky., 194 miles (312 km) are navigable.	Lock and Dam, Ore. (Mile 292); 12 feet at McNary Lock and Dam; 24 to 92 feet from McNary Lock and Dam to Kennewick Wash. (Mile 328); from Kennewick to Canadian border depths are variable due to regulation of reser- voirs.	Sand, gravel, sulphur, fluorspar, railroad ties, POL and POL products, sugar, molasses, coal, lig- nite, limestone, crushed rock, iron, steel.
Delaware River -----	Wilmington, Del., Philadelphia, Pa., Trenton, N.J.	128.4 miles (207 km) from Trenton to mouth at Dela- ware Bay (including auxiliary channel east of Burlington Island extend- ing from main channel to East Burlington, 1.4 miles (2.25 km)).	9 feet from mouth to Nash- ville, 194 miles (312 km); 6 feet from Nashville to Niagara Shoals, 137.4 miles (221 km); less than 1 foot, Niagara Shoals to Wolf Creek Dam, 129.3 miles (208 km); 9 feet at Wolf Creek Dam.	POL and POL products, glass, furnace slag, coal, coke, sand, gravel, grain and grain products, canned foods, sugar, molasses, soybeans, lumber and lum- ber products, woodpulp, paper and paper products, clays and earths, gypsum, sulphur, crushed rock, nonmetallic minerals, iron ore and concentrates, iron and steel, chrome, non- ferrous ores and metals, coal-tar products, sul- phuric acid, industrial chemicals, fertilizer and fertilizer and fertilizer minerals.
Green and Barren Rivers.	Bowling Green, Ky. ----	Green River—197.8 miles (318 km) from mouth to Mammoth Cave, Ky.; Bar-	5.5 feet for entire distance of both rivers—228 miles (367 km).	Bituminous coal and lignite, POL and POL products, limestone, sand, gravel,

Gulf intracoastal
waterway.

St. Marks, Fla., Carrabelle, Fla., Panama City, Fla., Pensacola, Fla., Mobile, Ala., New Orleans, La., Lake Charles, La., Port Arthur, Tex., Orange, Tex., Beaumont, Tex., Galveston, Tex., Texas City, Tex., Baytown, Tex., Houston, Tex., Port Lavaca, Tex., Corpus Christi, Tex., Port Isabel, Tex., Brownsville, Tex.

Houston Ship
Channel.

Houston, Tex.,
Galveston, Tex.

ren River—30.1 miles (48.5 km) from mouth (Mile 149.5 (241 km), Green River) to Bowling Green.

The main route extends 1,116 miles (1,795 km) from St. Marks River to the Mexican border at Brownsville, Tex., with a 55-mile (88.5 km) arm, known as the Plaque Mine-Morgan City Alternate Route, from the Mississippi River at Plaque Mine, La. (113 miles (182 km) above New Orleans) to the main route at Morgan City, La. (100 miles (161 km) west of New Orleans).

52 miles (83.6 km) from Galveston, across Galveston Bay through the San Jacinto River and Buffalo Bayou, with a light draft extension channel 7 miles (11.3 km) long from the Turning Basin to mouth of White Oak Bayou at Main Street, Houston, and a

crushed rock, iron and steel.

Seashells, coal, POL and POL products, iron and steel articles, iron and steel pipe and fittings, sulphur, acids, machinery and machines, clay, pulpwood, chemicals, alcohol, sugar, limestone, logs, salt, grain and grain products, molasses, soybeans, paper and paper products, lignite, cement, clays and earths, sulphur, sand, gravel, crushed rock, coal-tar products, industrial chemicals.

(1) *Main route*: 12 feet from St. Marks River to Pensacola Bay, 245 miles (394 km); 10.5 feet from Pensacola Bay to Mobile Bay, 46 miles (74 km); 11 feet from Mobile Bay to New Orleans, 134 miles (216 km); 12 feet from Mississippi River to Calcasieu River, La., 239 miles (385 km); 17 feet from Calcasieu River to Sabine River, Tex., 27 miles (43.4 km); 11 feet from Sabine River to Galveston, 90 miles (145 km); 10.9 feet from Galveston to Freeport, Tex., 42 miles (67.6 km); 11 feet from Freeport to Port O'Connor, Tex., 79 miles (127 km); 11.6 feet from Port O'Connor to Port Aransas, Tex., 61 miles (98.2 km); 10 feet from Port Aransas to Brownsville, 153 miles (246 km).

(2) *Plaque Mine-Morgan City route*: 9 feet for entire 55 miles (88.5 km).

36 feet in Houston Ship Channel; 36 feet in Turning Basin; 10 feet in extension to White Oak Bayou; 10 feet in branch behind Brady Island.

Seashells, grain and grain products, coffee, molasses, cotton, newsprint paper, other paper and paper products, coal and lignite, POL and POL products, cement, clays and earths, sulphur, sand, gravel, crushed rock, iron and steel, coal-tar products,

<i>Name of waterway</i>	<i>Principal terminals</i>	<i>Critical distances</i>	<i>Controlling depths for specified locations</i>	<i>Typical cargo carried commercially</i>
		branch channel in the old channel of Buffalo Bayou behind Brady Island.		sulphuric acid, industrial chemicals, fertilizer and fertilizer materials.
Hudson River -----	New York, N.Y., Tarry- town, N.Y., Waterford, N.Y., Poughkeepsie, N.Y., Albany, N.Y., Troy, N.Y.	155 (249 km) miles from New York City (Battery) to Waterford.	40 feet from New York City (Battery) to Spuyten Duyvil Creek. 13 miles (20.9 km); 27 feet from Spuyten Duyvil Creek (Harlem River) to Albany, 131 miles (211 km); 14 feet to Waterford, 11 miles (17.7 km).	Copper ore and concentrates, sand and gravel, sugar, coal, lumber, shingles and lath, stone and rock, POL and POL products, coal- tar, copper, syrup and molasses, woodpulp, grain and grain products, auto- mobiles, cement, brick.
Illinois waterway ----	Grafton, Ill., Pekin, Ill., Peoria, Ill., Chicago, Ill.	Includes the Illinois River from its mouth on Missis- sippi River at Grafton to Lockport, Ill., 291 miles (469 km); the Chicago Sanitary and Ship Canal (Chicago Drainage Canal) from Lockport to Damen Avenue, Chicago, 30 miles (48.3 km); the Chicago River (South Branch) from Damen Avenue to Lake St., Chicago, 4.5 miles (7.24 km); and the Calumet-Sag Channel from its junction with the Chi- cago Sanitary and Ship Canal to Blue Island, Ill., the Little Calumet and Calumet Rivers to Turning Basin No. 5, 23.8 miles (38.3 km).	9 feet in the Illinois River from its mouth on Missis- sippi River at Grafton to Lockport, 291 miles (469 km); 16.8 feet in the Chi- cago Sanitary and Ship Canal from Lockport to Damen Avenue, Chicago, 30 miles (48.3 km); 21 feet in the Chicago river (South Branch) from Damen Avenue to Lake St., Chi- cago; 4.5 miles (7.24 km); and 9 feet in the Calumet- Sag Channel from its junction with the Chicago Sanitary and Ship Canal to Blue Island, Ill., to Little Calumet and Calu- met Rivers to Turning Basin No. 5, 23.8 miles (38.3 km).	Newsprint paper, other paper and paper products, sulphur, sand, gravel, iron and steel articles, grain and grain products, coal, POL and POL products, phosphate rock, chemicals, sugar, iron and steel scrap, limestone, cement, soy- beans, molding sand, mo- lasses, lignite, crushed rock, coal-tar products, fertilizer and fertilizer materials.
Kanawha River -----	Henderson, W.Va., Point Pleasant, Va.	97 miles (156 km) from junction of New and Gauley Rivers in W.Va. to mouth at Point Pleasant on Ohio River. The navigable portion extends 90 miles (145 km) upstream from mouth.	9 feet for the 90 miles (145 km) above mouth.	Sand and gravel, coal, coke, POL and POL products, sulphur, acids and other chemicals, furnace slag, alcohol, iron and steel, coal-tar products.

Kentucky River -----	Beattyville, Ky., Carrollton, Ky.	258.6 miles (416 km) from where it is formed by the confluence of the north and middle forks, about 4 miles (6.44 km) east of Beattyville to mouth at Carrollton.	6 feet for entire length ----	Sand, gravel, crushed rock, gasoline and other motor fuels, coal and lignite.
Mississippi River ----	Minneapolis, Minn., St. Paul, Minn., St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Vicksburg, Miss., Baton Rouge, La., New Orleans, La.	2,350 miles (3,780 km) from its source in Lake Itasca in central Minnesota to the Gulf of Mexico (513 miles (826 km) from Lake Itasca to Minneapolis, 853 miles (1,373 km) from Minneapolis to mouth of Ohio River, 964 miles (1,550 km) from mouth of Ohio River to Head of Passes, La., and 20 miles (32.2 km) from Head of Passes to Gulf of Mexico through Southwest Pass).	Commercial navigation above Minneapolis is prohibited by insufficient depths. From Minneapolis to the Gulf (1,837 miles (2,960 km)), the following controlling depths prevail: 9 feet, Minneapolis to Baton Rouge, 1,588 miles (2,560 km); 35 feet, Baton Rouge to Head of Passes, 229 miles (369 km); and 40 feet from Head of Passes through Southwest Pass to the mouth of the Pass (Gulf of Mexico), 20 miles (32.2 km).	Coffee, sugar, molasses, syrup and honey, rubber, vegetable fibers, aluminum ore, alloys and scrap, grain and grain products, oilseeds (except flaxseed), cotton and cotton linters, sawmill products, sulphur, salt, POL, iron and steel products, fertilizer and fertilizer materials, soda products, alcohol, other chemicals, seashells, bauxite ore, sand and gravel, coal, logs and lumber, iron and steel pipe and fittings, machinery, automobiles, cement and concrete products, brick, bags and bagging, iron and steel scrap.
Missouri River -----	Sioux City, Iowa, Omaha, Neb., Council Bluffs, Iowa, St. Joseph, Mo., Kansas City, Kans., Kansas City, Mo., Independence, Mo., Jefferson City, Mo., St. Louis, Mo.	2,464 miles (3,960 km) from junction of the Jefferson, Madison, and Gallatin Rivers at Three Forks, Mont., to the mouth which enters the Mississippi River 17 miles (27.4 km) above St. Louis. Regular commercial navigation only on the portion improved for navigation from Sioux City to the mouth, 762 miles (1,225 km), consisting of two sections: 376 miles (606 km) from Sioux City to the upper end of Quindaro Bend near	9 feet from mouth to mouth of Big Sioux River at Sioux City, 762 miles (1,225 km); 1 1/2 to 2 1/2 feet from mouth of Big Sioux to Fort Benton, Mont.	Grain and grain products, soybeans, molasses, logs, POL and POL products, sand, gravel, crushed rock, iron and steel, waterway improvement material, metal products and parts, wood posts, poles and piling, machinery and machines.

<i>Name of waterway</i>	<i>Principal terminals</i>	<i>Critical distances</i>	<i>Controlling depths for specified locations</i>	<i>Typical cargo carried commercially</i>
Monongahela River	Pittsburgh, Pa., Fairmont, W.Va.	Kansas City, Mo., and 386 miles (622 km) from Kansas City to the mouth. 128 miles (206 km) from its formation by the junction of the Tygart and West Fork Rivers (about 1 mile south of Fairmont) to mouth at Pittsburgh.	9 feet for entire length -----	Sand and gravel, coal, coke, fluorspar, sulphur, POL and POL products, sulphuric acid, iron and steel articles, pipe and fittings, ferrous scrap, furnace slag, nonmetallic minerals, coal-tar products, industrial chemicals.
New York State Barge Canal.	New York, N.Y., Albany, N.Y., Buffalo, N.Y.	There are 522 miles (840 km) of waterways as follows: (1) Erie Canal from Waterford on the Hudson River to Tonawanda on the Niagara River, 338 miles (544 km); (2) Oswego Canal from Three Rivers Point, N.Y., (on Erie Canal 160 miles (258 km) west of Waterford) to Oswego on Lake Ontario, 24 miles (38.6 km); (3) Cayuga and Seneca Canals, 90 miles (145 km), connecting with the Erie Canal near the confluence of the Seneca and Clyde Rivers; (4) Champlain Canal from Waterford, on the Hudson River (entrance to Erie Canal) to Whitesall at the south end of Lake Champlain, 60 miles (96.6 km); (5) 10 miles (16.1 km) of connecting channels to canal harbors at Utica, Syracuse, and Rochester.	14 feet in earth cuts, rock cuts, canalized rivers and lakes and in open rivers; 12 feet in locks.	Grain and grain products, POL and POL products, pulpwood, chemicals, fertilizer, paper and paper products, molasses, clay, scrap iron, pig iron and billets, sugar, bituminous materials.
Ohio River -----	Pittsburgh, Pa., Cincinnati, O., Louisville, Ky.,	981 miles (1,580 km) from Pittsburgh to Cairo.	9 feet for entire distance ---	Grain and grain products, coal, railroad ties, coke,

Evansville, Ind., Cairo,
Ill.

sand and gravel, stone and rock, POL and POL products, sulphur, fluorspar, lumber, shingles and lath, sulphuric acid, alcohol, other chemicals, tar, pitch, creosote, iron and steel articles (including pipe and fittings), automobiles, cement, iron and steel scrap, furnace slag.

Sacramento River --- Colusa, Calif., Sacramento, Calif., Benicia, Calif., San Francisco, Calif.

245 miles (394 km) from mouth of river at Collinsville, Calif., to Red Bluff.

20 feet from mouth of river to Cache Slough, 15 miles (24.1 km); 8 feet from Cache Slough to Sacramento, 44 miles (70.8 km); 6 feet from Sacramento to Colusa, 85 miles; 2 feet from Colusa to Chico Landing, 49 miles (79 km); 1.5 feet from Chico Landing to Red Bluff, 52 miles (83.7 km).

Grain and grain products, sugar, beets, rock and stone, POL and POL products, canned foods, beet pulp, sand, gravel, fresh vegetables.

San Joaquin River --- Stockton, Calif.

127 miles (204 km) from mouth of New York Slough to Hills Ferry. The river consists of two sections: mouth to Stockton (navigable all year), 41 miles (66 km); Stockton Channel to Hills Ferry (navigable April through June), 86 miles (138.5 km).

28 feet from mouth of New York Slough to Mormon Channel, Stockton, Mile 40; 22 feet (with other connecting channels 2 to 9 feet) to Edison Street, Stockton, Mile 41 (navigable all year); 4 feet from junction with Stockton Channel to Mossdale Bridge, Mile 16; 3 feet to Hills Ferry, Mile 86 (navigable April through June).

Canned milk, grain and grain products, fresh and canned vegetables, dried and canned fruits, molasses, POL and POL products, sand, gravel, crushed rock, iron ore, iron and steel, industrial chemicals.

Tennessee River ----- Knoxville, Tenn., Chattanooga, Tenn., Decatur, Ala., Florence, Ala., Paducah, Ky.

652 miles (1,050 km) from its formation by the junction of the French Broad and Holston Rivers in eastern Tennessee, 4.4 miles (7.08 km) above Knoxville to the mouth at Paducah on the Ohio River.

9 feet from mouth to Knoxville, 647.6 miles (1,040 km).

Grain, coal, coke, clay, POL and POL products, sand, gravel, railroad ties, automobiles, lumber, soybeans, pulpwood, sulphur, limestone, salt, iron and steel, manganese, coal-tar products, chemicals.

5-32. Amphibious Operations

a. Each amphibious landing differs in climatic, hydrographic, and topographic conditions, as well as in the military situation. These variable factors make it impractical to develop detail logistical planning data applicable only to beaches and their capacity to receive troops and cargo; however, certain general planning data can be developed.

b. Beach capacity is the amount of cargo that can be discharged over a given beach length within a stated interval of time. During the initial phases of an amphibious operation, beach capacity is limited to the beach or beaches over which the assault landing is being made; later, if necessary, overall capacity may be increased by the consolidation of beaches for more efficient operation and for the opening up of sheltered unloading points in rivers or bays. Experience has indicated that, during the assault phase of an operation, cargo can be landed and moved across beaches as follows, using (1) and/or (2) in appropriate combination:

(1) Average short tons of cargo per day per mile (1.6 km) of beach—3,000. Average per 1,000 yards (914 meters) of beach—1,700.

(2) Average number of vehicles and personnel landed simultaneously per day per mile of beach—675 vehicles, 4,725 personnel.

c. To insure successful accomplishment of an amphibious operation, equipment and supplies must be loaded so as to provide maximum support to the landing plan and the scheme of maneuver ashore. The manner in which a ship is loaded determines the order and speed with which equipment and supplies can be unloaded and made available for tactical employment. The composition of amphibious task forces will seldom, if ever, be alike. The methods of loading the ships assigned to transport an amphibious force normally will be determined after careful consideration of the following factors:

(1) Availability of shipping versus lift requirements for the operation.

(2) Unloading capability in the objective area versus desired rate of buildup ashore.

(3) Availability of time versus requirements for detailed and thorough coordination and planning.

(4) Availability of ship-to-shore means versus requirements for assault craft in the ship-to-shore movement.

(5) Desired rate of combat force buildup versus base development requirements during assault phase.

(6) Requirements for special equipment versus availability.

(7) Conflicts between time requirements and variable weather and climatic conditions.

d. Types of Military Loading.

(1) *Administrative loading.* Administrative loading makes maximum use of troop billeting and cargo spaces. There is no regard for tactical considerations, unit integrity, or priority for unloading. It is used when direct opposition from the enemy will not be encountered upon landing. This method of landing may be employed when personnel and cargo are transported to the objective area in followup shipping or when tactical employment immediately upon landing is not required. Technical details pertaining to administrative loading are contained in TM 55-513.

(2) *Combat loading.*

(a) Combat loading is used for any operation in which opposition from the enemy is anticipated. Combat loading is designed to insure unit integrity and maximum unloading efficiency of the individual embarkation teams and the landing force as a whole. All other considerations, such as economy of space, must be subordinate. Selected units, with their essential combat equipment and supplies, are loaded in such a manner that they will be available to support the tactical plan upon debarkation. Ships must be loaded to provide for flexibility to meet possible changes in the tactical plan and to facilitate discharge of cargo to meet emergency calls for equipment or supplies. Two objectives of combat loading are—

1. That supplies and equipment loaded aboard ship are so stowed as to be available for unloading and delivery to the as-

sault forces at the time and in the order required to support the tactical situation ashore.

2. That the troops, equipment, and supplies are dispersed throughout the amphibious force shipping in such a manner that the loss or diversion of an embarkation team will not materially affect the tactical integrity of the force embarked in the remaining ships.

(b) There are three types of combat loading which may be employed, depending upon the mission, organization, types of equipment assigned to the force (including ships), and the planned tactical employment of the force. There are—

1. *Combat unit loading.* Combat unit loading is the loading of an assault troop organization, together with its essential combat equipment and supplies, in a single ship in such a manner that it will be available to support the tactical plan upon debarkation. Combat unit loading provides maximum flexibility to meet possible changes in the tactical plan.

2. *Combat organizational loading.* Combat organizational loading is the loading of a troop organization with its equipment and supplies on the same ship, but without regard to tactical considerations upon debarkation. It permits debarkation of complete units and equipment which will be available for tactical employment after assembly ashore. This method is more economical in ship space than combat unit loading.

3. *Combat spread loading.* Combat spread loading is the loading of troop organizations with their equipment and supplies on two or more ships. This method is commonly used in loading organizations equipped with numerous vehicles and/or large amounts of heavy equipment. Organizations so loaded are available for employment in the landing area upon reassembly of personnel and equipment after landing.

(c) Technical details pertaining to combat loading are contained in FM 60-30.

(3) *Commodity loading.* Commodity loading is a method of loading in which various types of cargo such as ammunition, rations, or boxed vehicles are stowed separately in order that each commodity can be discharged with-

out disturbing other cargo. It is also called block stowage. Portions of compartments are completely filled with items of the particular commodity and are separated from other commodities. Ships are often completely commodity loaded when the cargo consists of class V supplies.

(4) *Selective loading.* Selective loading is a method of loading and stowing equipment and supplies aboard ship in a manner designed to facilitate issue to designated units. Supplies and equipment are stowed so that they can be discharged and delivered on call. Selective loading differs from commodity loading in that all classes of supplies required to support specified units are loaded and stowed so as to be discharged according to planned and/or anticipated requirements.

5-33. Wheeled Amphibians

a. Characteristics.

(1) *LARC-V.* The combat payload of the LARC-V amphibian ranges from 5,000 to 10,000 pounds depending on the operating conditions. For planning purposes, the combat payload of the LARC-V is 10,000 pounds under ideal conditions; however, the payload may be reduced to 5,000 pounds, depending on wind, waves, or obstacles. Very unfavorable conditions may cause operations to cease entirely.

(2) *LARC-XV.* This craft is intermediate in size between the LARC-V and the LARC-LX with a combat payload carrying capacity of 30,000 pounds under ideal conditions. This figure may be reduced depending upon immediate environmental factors.

(3) *LARC-LX.* The combat payload of the LARC-LX ranges up to 120,000 pounds depending upon operating conditions. In extreme cases and under ideal conditions, the LARC-LX may transport 200,000 pounds. The combat payload will vary in accordance with operating conditions. Very unfavorable operating conditions could cause operations to cease entirely.

b. *Operating Conditions.* The various factors influencing operating conditions are shown below.

Factors affecting operating conditions	Ideal	Operating conditions Favorable	Difficult
Wind -----	10 mph (16 kmph) or less	10 to 15 mph (16 to 24 kmph).	Over 15 mph (24 kmph).
Waves -----	Less than 1 ft -----	1 to 3 ft -----	Over 3 ft.
Beach -----	Gentle slope, hard sand--	Abrupt slope, soft sand --	Construction re-required. Mud.
Obstacles -----	None -----	Some -----	Prevalent.
Area behind beach -----	Good road net -----	Trails -----	Cross-country.

c. Estimating Requirements. This requires computation of turn around time. The accepted average turnaround time factors used for planning purposes are listed below. Whenever possible, data derived from actual operating

experience should be substituted for these average factors. When estimating requirements, allowance should be made for the tactical situation and for possible adverse navigation, weather, and road conditions.

	LARC-V	LARC-LX
Loading time -----	8-10 min -----	25 min (heavy vehicles).
Unloading time -----	8-10 min -----	5 min (with unloading pit prepared).
Water speed -----	10 mph (16 kmph) -----	8 mph (13 kmph).
Land speed -----	25 mph (40 kmph) -----	14 mph (23 kmph).

Note. Data on LARC-XV not available.

d. Turnaround Time. Turnaround time for wheeled amphibians may be estimated by using the following formula:

$$TT = \frac{W \times 60}{R} + \frac{L \times 60}{R'} + a + b + c$$

where

- TT* = turnaround time in minutes
- *W* = water distance (round trip) in miles or kilometers
- *L* = land distance (round trip) in miles or kilometers
- *R* = speed on water in miles or kilometers per hour
- *R'* = speed on land in miles or kilometers per hour
- a* = loading time in minutes
- b* = unloading time in minutes (not to exceed loading time)
- c* = known delays in minutes

*If metric system is used, it must be adhered to for *W*, *L*, *R*, and *R'*.

e. Continuous Operations. For continuous operations, a planning factor of 75 percent availability of assigned amphibians is assumed because of maintenance requirements. To estimate the number of operational vehicles required for a particular mission, use the formula given below.

$$V = \frac{H \times TT}{X}$$

where

- V* = number of operational vehicles
- H* = number of hatches to be worked
- TT* = turnaround time in minutes
- X* = most restrictive factor (*a*, *b*, or *c*, whichever is greatest in solution of turnaround time in subparagraph *d* above).

5-34. Logistics-Over-the-Shore (Lots) Operations

a. LOTS operations provide for the movement of cargo and personnel over the shore between ocean transportation and shoreside facilities. Beaches and other more difficult shorelines are used to the extent required. Figure 5-21 shows a typical transportation terminal battalion organization for LOTS operations.

b. LOTS operations include—

- (1) Unloading cargo and personnel from ships into landing craft and/or amphibians.
- (2) Moving cargo and personnel by landing craft and/or amphibians from ships to shore.
- (3) Unloading landing craft at beaches.

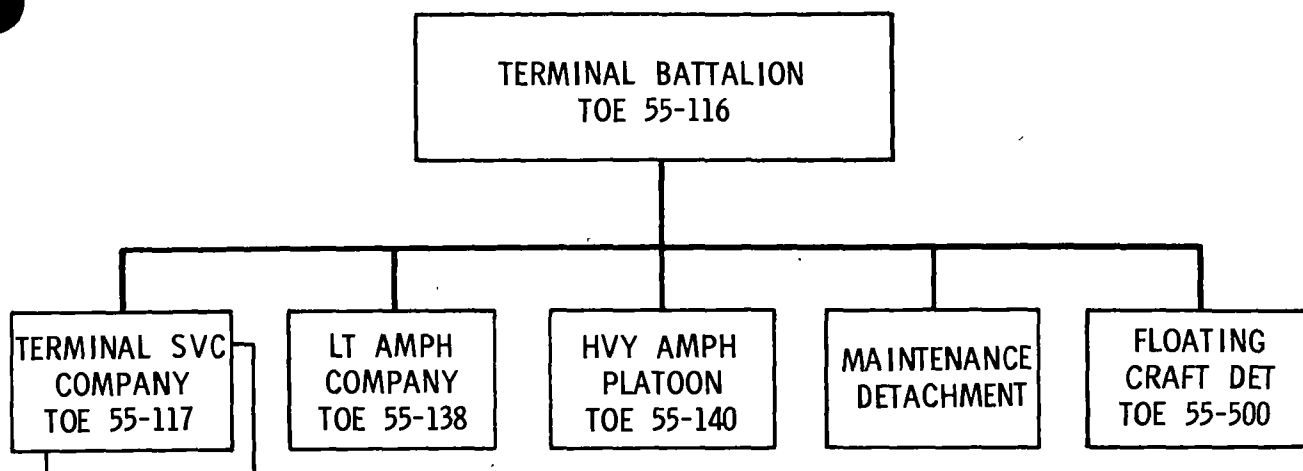


Figure 5-21. A typical transportation terminal battalion organized for a LOTS operation.

(4) Unloading amphibians at transfer points.

(5) Moving cargo from landing craft to temporary storage and/or segregation areas or to destination.

(6) Unloading at storage areas or transfer points.

c. Planning factors for LOTS operations are essentially the same as those for fixed terminal operations. Using ship's gear and stevedore labor provided by the forces offshore, ships normally can discharge cargo into special landing equipment as fast as beaches can receive and clear the loaded landing craft and amphibians. In an amphibious operation, the site selections for subsequent LOTS operations are included in the base development plan: Where LOTS operations are established independently, the selection of possible beach sites is made by the terminal commander in consultation with the proper naval authorities, by an extensive study of maps and hydrographic charts, and by reference to pertinent intelligence surveys, when available. Final determination of the feasibility of operations at possible sites is made by a detailed ground and water reconnaissance. The information may be compiled as shown on the sample reporting format (fig. 5-22). This completed form is accompanied by a detailed profile sketch of the beach and landing area as shown in figure 5-23.

5-35. Hydrographic Markings for Landing Operations (fig. 5-24)

a. Hydrographic markings have been developed for use in beach operations in areas not otherwise suitably marked. They are normally installed by transportation personnel or by shore party personnel. They are not related to the aids to navigation maintained by the Coast Guard.

b. During the day, a pennant with alternate red and black vertical stripes is fastened to a buoy or stake to show the locations of rocks, shoals, or submerged obstacles. This pennant is replaced at night by a white light over a red light, both blinking.

c. Hydrographic markings for channels consist of the following:

(1) A red pennant by day and a steady red light at night mark the starboard side of the channel for boats coming from seaward.

(2) A black pennant by day and a blinking white light by night mark the port side.

(3) A black and white vertically striped pennant by day and a blinking green light at night mark a fairway.

(4) Two blinking green lights, one over the other, indicate a range (TM 55-508).

CHARACTERISTICS OF BEACHES AND LANDING AREAS - TRANSPORTATION INTELLIGENCE				NAME OF FACILITY Marlin Area Beaches		PREPARED BY J. B. MORTON, Major, TC		HEADQUARTERS 35th Trans Intal Team (Collection)		KEY NA - Not Applicable		PAGE NUMBER 3	NUMBER OF PAGES 7
BEACH NUMBER AND LOCATION	LENGTH OF BEACH		WIDTH OF BEACH		BEACH GRADIENTS		APPROACH (Bottom gradients, water depths, sands, reefs, etc.)	SURF AND TIDAL RANGE	MATERIAL AND FIRMNESS	DESCRIPTION OF TERRAIN IMMEDIATELY BEHIND BEACH	EXITS AND COMMUNICATIONS INLAND		
	OVERALL LENGTH	USABLE LENGTH	LOW WATER	HIGH WATER	LOW WATER	HIGH WATER							
No. 22. Centered 600 yd NE of Leander and 8.6 mi SW of Ocean View at 11°12' N, 22°22' E	2,000 yd	All usable	Aprx 30 yd	Aprx 20 yd	Aprx 1 in 30	1 in 20	Near shore bottom slopes flat; 2.4-to 4.6-ft depths 30 yd offshore; 6.8-ft depth 400 yd SW end 700 yd off SE end of beach. Approach from NW and bay generally clear over shoal depth with some rocky patches. Approach flanked on SE by small islands, reefs, and rocks, which extend for about 2 miles NW of Leghorn. Bottom mud and sand; weedy close to shore.	Surf rough with prevailing winds; tidal range 1.0 ft, spring tides.	Sand: soft and fine; firm only in wetted area.	Soft, sandy back-shore generally unsuitable for wheeled vehicles, backed by a sea wall and 900 yd of sand hummocks 4.6 ft high, covered with brush; all on a flat, open plain.	Across 900 yd sandy terrain by narrow one-lane road to a primary road and railroad leading to Leander.		
No. 12 Seaview to Lakeland; centered 22°26' N, 33°36' E. On sandspit terminated on W by entrance channel into Lake Yerba	5.2 miles	4.6 miles usable	Aprx 85 yd	Aprx 50 yd	Aprx 1 in 50	1 in 50	Near shore bottom slopes mild to flat; 6-ft depth generally 160 yd off beach except at W end where 400 yd offshore; 18-ft depth 2.0 miles offshore; approach clear over gradually shoaling sand and mud bottom; 30-ft anchorage 4.0 mile offshore E of breakwater. Bottom hard sand.	Surf rough with onshore winds; tidal range aprx 1.6 ft, spring tides.	Sand and sandstone--believed to be firm.	Low sand dunes backed by hilly sandy terrain as high as 40 ft and completely covered with vegetation; terrain directly back of beach flanked on E and W by vast salt marshes.	A primary road parallels the shore about 2.0 miles inland; railroad parallels the shore 3 miles from beach. Cross-country exit across dune area to network of minor roads or trails connecting with secondary road, connecting with primary road at Hildale.		
REMARKS													
NOTE: Beach lengths and distances along the coast and inland are expressed in statute miles. Distances across water are expressed in nautical miles except when referring to beach locations.						DATE 27 June 1961	TYPED NAME AND GRADE B. C. DALTON, Lt Colonel, TC, Commanding			SIGNATURE <i>B. C. Dalton</i>			

Figure 5-22. Characteristics of beaches and landing areas.

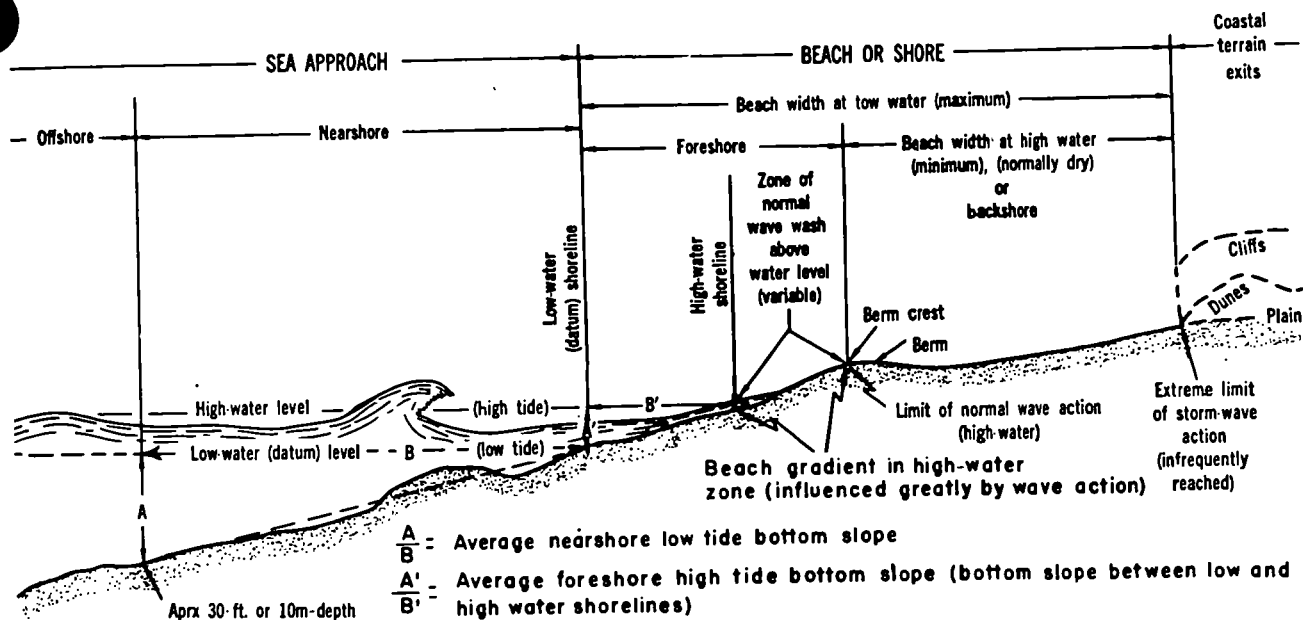


Figure 5-23. Beach profile diagram.

5-36. Beach and Debarkation Point Markers (fig. 5-25)

a. During the process of beach organization, debarkation points for various categories of supply and equipment are selected on each beach where they best support the tactical plan. Beach markers and debarkation point markers are erected by shore party personnel as soon as possible after the initial assault of an amphibious landing has been made.

b. Beach markers are large pieces of cloth

secured to supports and held aloft. Beaches under attack are given a color designation, such as Red Beach, Green Beach, etc., and beach markers are constructed in corresponding colors. The center of a beach is marked by a large square of cloth with the color facing seaward. The left flank of the beach, as seen from the sea, is denoted by a horizontal rectangle of the same color; the right flank is marked by a vertical rectangle, also of the same color. Debarkation-point markers are set up to indicate to the craft crews where the various types of cargo are to be landed.

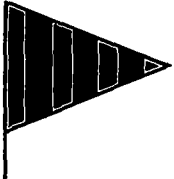
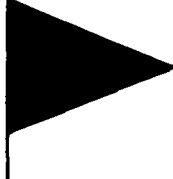
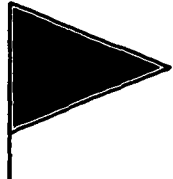
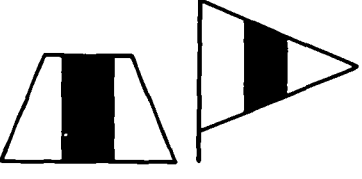
HYDROGRAPHIC MARKERS (FROM SEAWARD)				
	ROCKS, SHOALS, & OBSTRUCTION	PORT	STARBOARD	FAIRWAY OF CHANNEL
DAY				
NIGHT				
LEGEND : ○ STEADY LIGHT ◎ BLINKING LIGHT				

Figure 5-24. Hydrographic markings for landing operations.

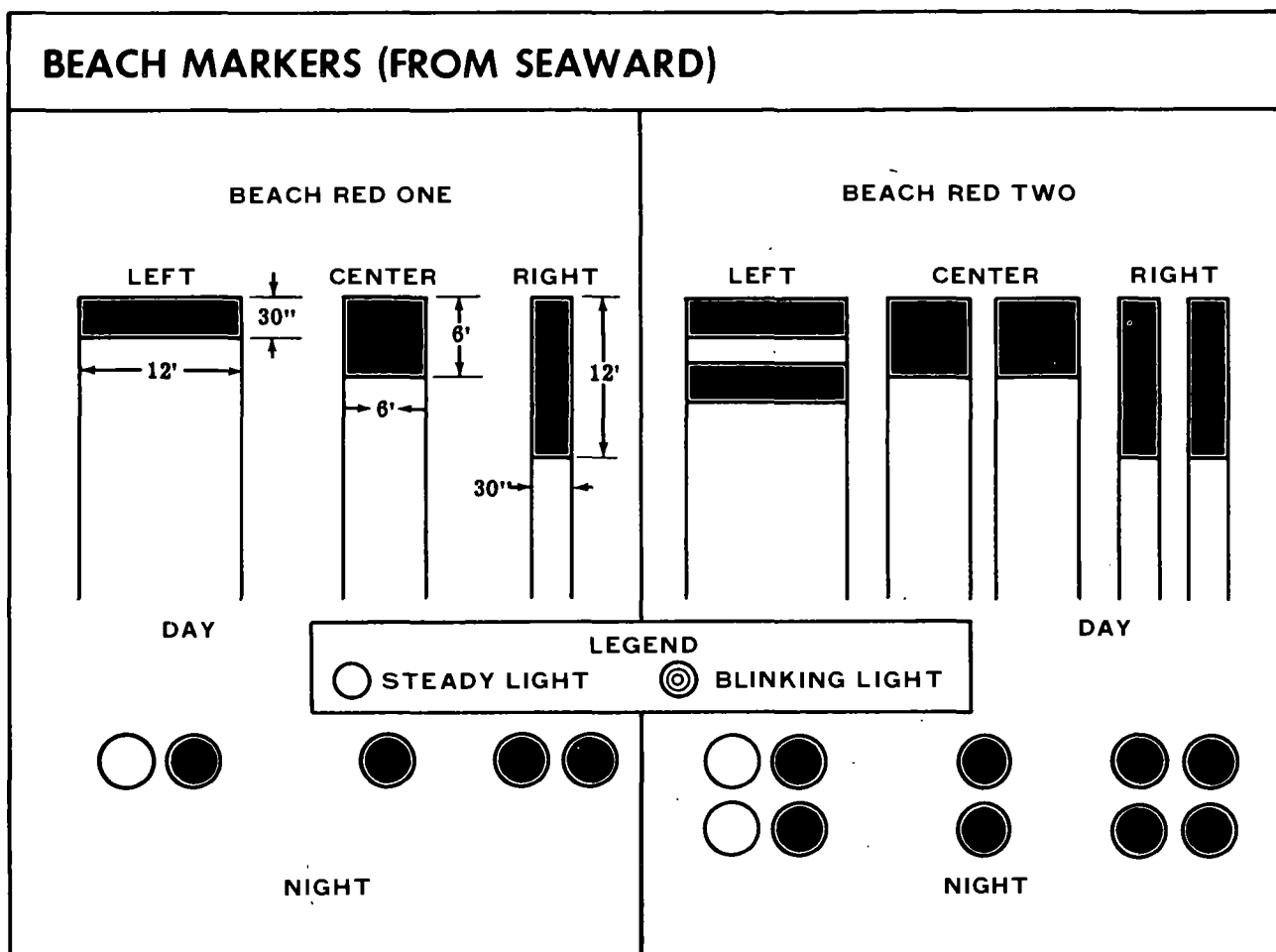


Figure 5-25. Beach and debarkation point markers.

MISCELLANEOUS BEACH SIGNS

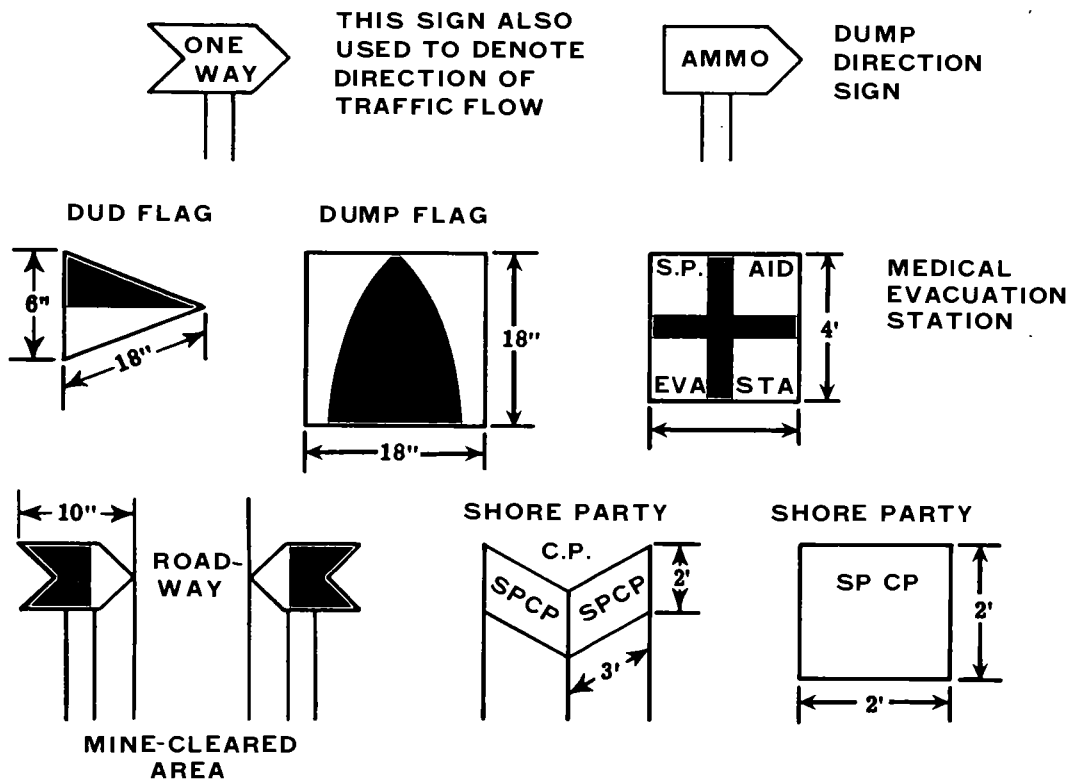


Figure 5-25—Continued.

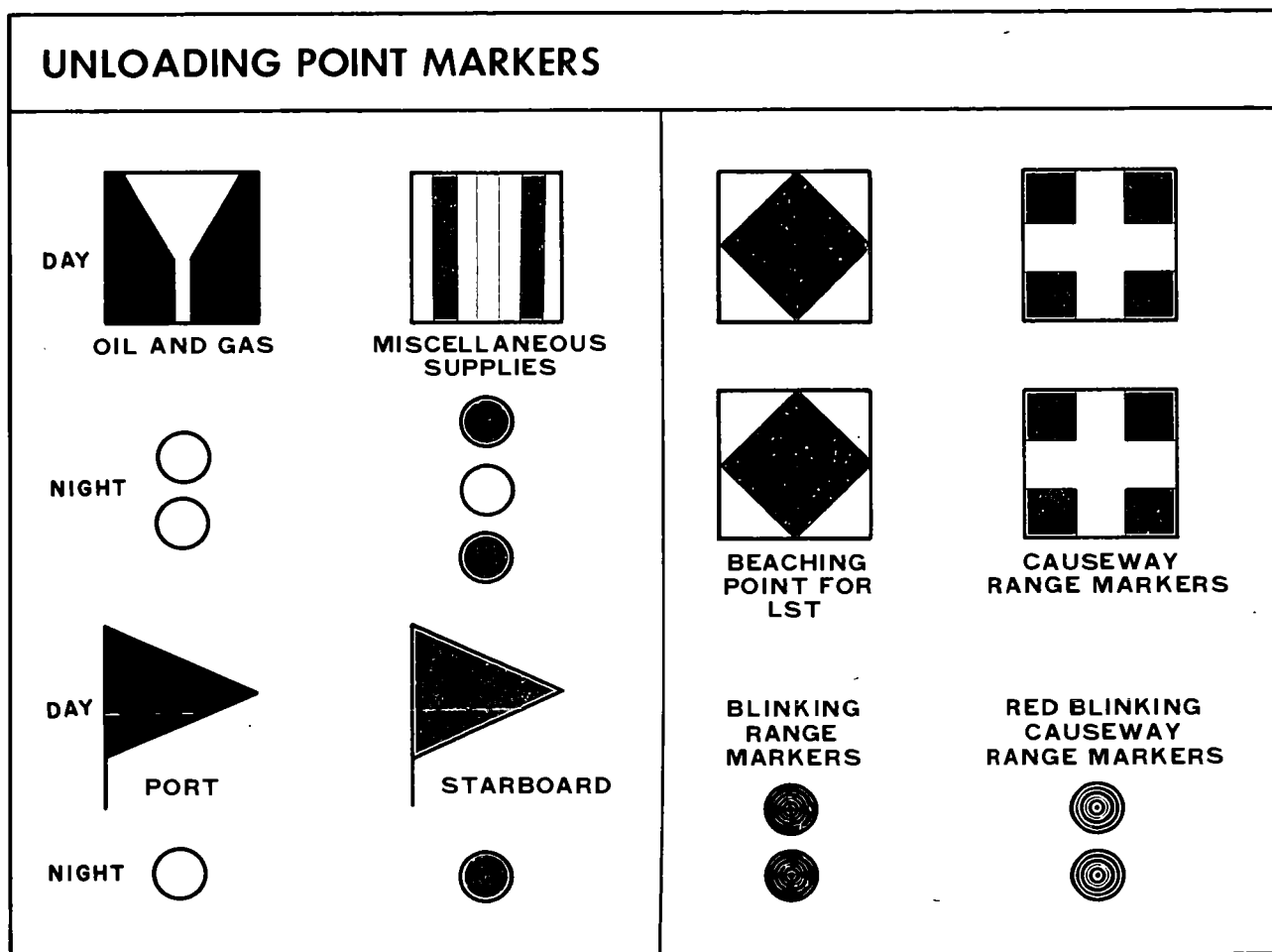


Figure 5-25—Continued.

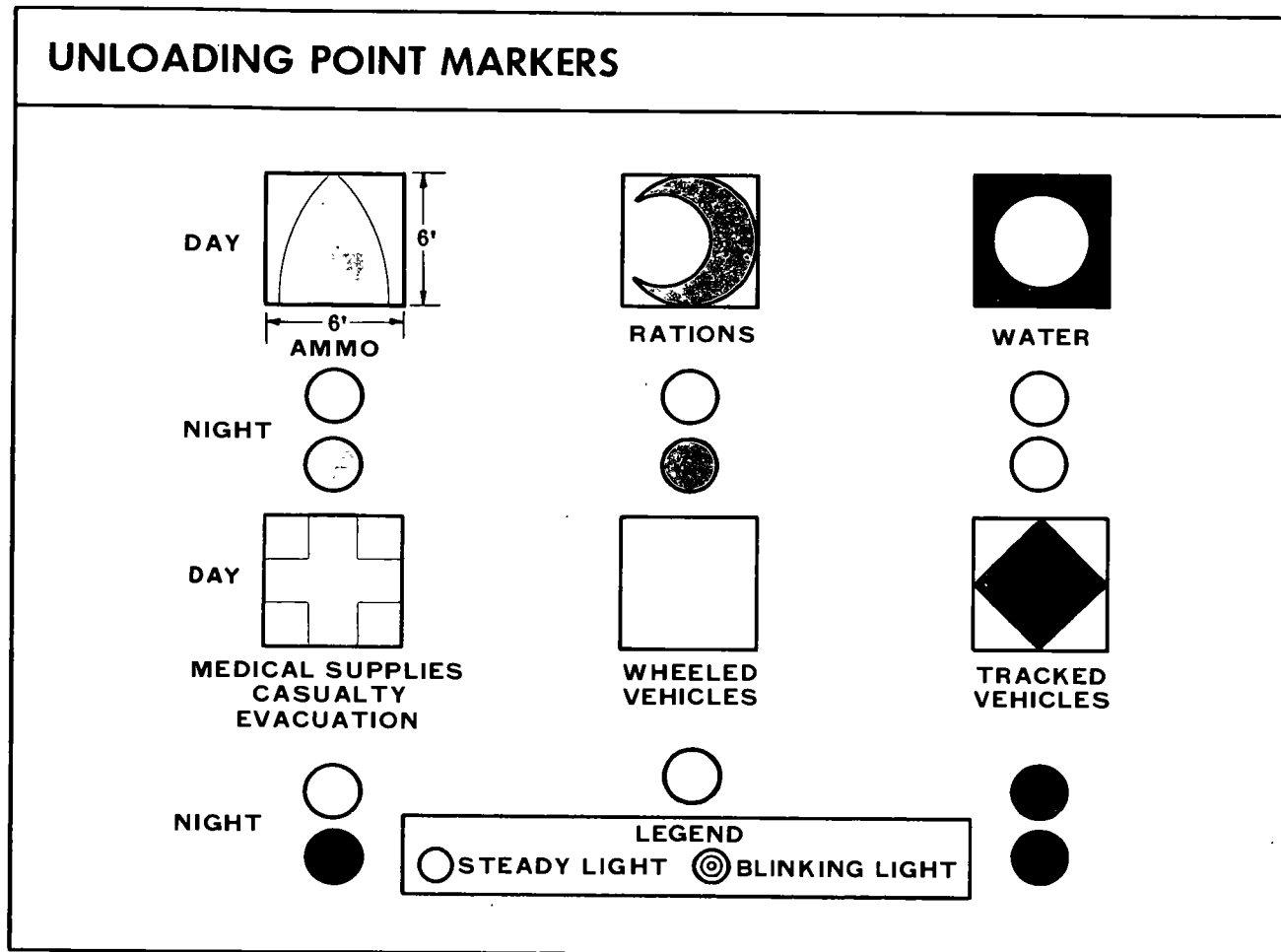


Figure 5-25—Continued.

Section IV. HOISTING AND CONVEYING DATA

5-37. Strength of Rope

a. The safe working capacity in tons for any size of manila rope is approximately equal to the square of the diameter in inches if a safety factor of 4 is used. In exceptional cases the rated safe working load may be exceeded, but under no circumstances should rope be loaded to more than twice its safe working capacity.

b. A rope sling over a hook is reduced in strength by approximately 30 percent. Sharp bends over corners further reduce the strength

of the rope. Sand or grit between the fibers or exposure to heat will destroy the fibers and rapidly reduce the strength of the rope.

5-38. Properties of Manila Rope

The following table is for new manila rope used under favorable conditions. As rope ages or deteriorates, progressively reduce safe loads to one-half of values given. To determine the safe working load of sisal rope, deduct one-fifth from the safe working load of manila rope of the same size.

Nominal diameter (inches)	Circumference (inches)	Weight per 100 feet (pounds)	Breaking strength (pounds)	Safe load (pounds)*
1/4	3/4	2.0	600	150
3/8	1 1/8	4.10	1,350	335
1/2	1 1/2	7.50	2,650	660
5/8	2	13.3	4,400	1,100
3/4	2 1/4	16.7	5,400	1,350
7/8	2 3/4	22.5	7,700	1,920
1	3	27.0	9,000	2,250
1 1/8	3 1/2	36.0	12,000	3,000
1 1/4	3 3/4	41.8	13,500	3,380
1 1/2	4 1/2	60.0	18,500	4,620
1 3/4	5 1/2	89.5	26,500	6,625
2	6	108.0	31,000	7,750
2 1/2	7 1/2	167.0	46,500	11,620
3	9	242.0	64,000	16,000

*Safety factor of 4.

5-39. Knots, Bends, and Hitches

Knots, bends, and hitches used to work lines aboard a vessel and in terminal operations are shown in figure 5-26.

5-40. Wire Rope

Wire rope varies considerably in construction characteristics and in the quality of steel used. In terminal operations, the most common rope constructions are 6 strands of 7 wires each and 6 strands of 19 wires each. The 6 x 7 wire

rope, being stiffer, is suitable for guys, stays, and other stabilized uses where the rope does not bend around sheaves or drums. The more pliable 6 x 19 wire rope is suitable for hoisting use involving sheaves and drums. For a given rope size and type of steel (plow steel is most commonly used) the strength of wire rope varies only slightly with the strand construction and number of strands. The maximum allowable working load is the breaking strength divided by the appropriate safety factor. Characteristics of 6 x 19 wire rope are as follows:

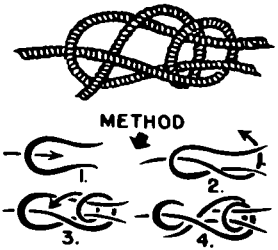
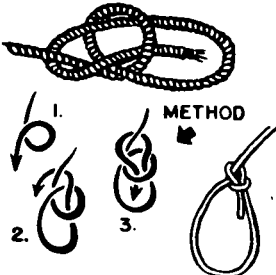
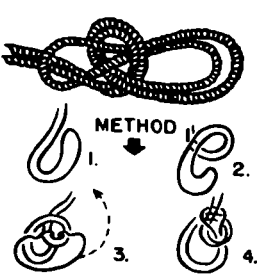
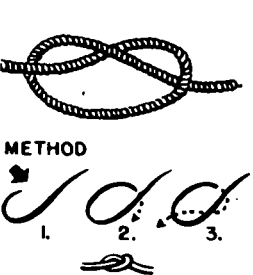
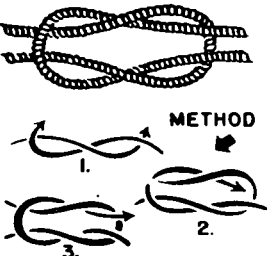
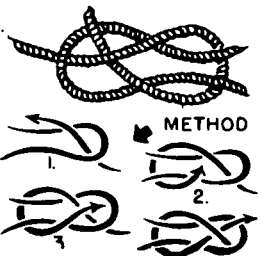
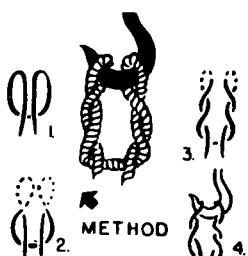
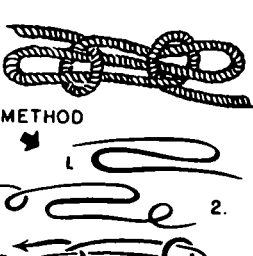
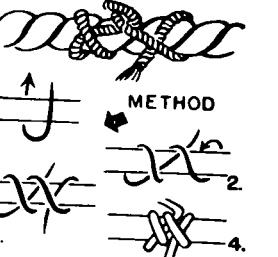
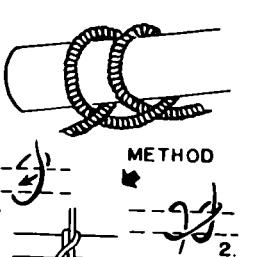
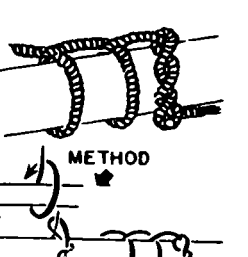
 DOUBLE-SHEET BEND To join two wet ropes of different diameters.	 BOWLINE To form a loop of any desired size that will not slip.	 BOWLINE ON A BIGHT To form a loop with a double purchase. To form a loop in a rope when the ends are not available.	 OVERHAND KNOT To prevent the end of a rope from unravelling. To prevent the end from passing back through the sheave of a block.
 SQUARE KNOT To join ends of the same rope. To tie together two ropes of equal diameter.	 SINGLE-SHEET BEND To join two ropes of different diameters.	 CAT'S PAW To obtain a double bearing surface on a hook.	 SHEEPSHANK To shorten a rope when ends are not available. To bypass a weak section of a rope when ends are not available.
 ROLLING HITCH To form a hitch which will hold on a spar or rope yet will slide readily upon a slight adjustment.	 GLOVE HITCH To fasten guy lines to anchorages and spars.	 TIMBER HITCH WITH TWO HALF HITCHES To haul a log, spar, guntube, or any long cylindrical object with the pull line parallel to the object drawn.	 BLACKWALL HITCH To secure a rope to a hook rapidly.

Figure 5-26. Knots, bends, and hitches.

Diameter (inches)	Approximate weight per 100 feet (pounds)	Breaking strength (short tons)		
		Mild plow steel	Plow steel	Improved plow steel
1/4	10	2.07	2.39	2.74
5/16	16	3.31	3.82	4.23
3/8	23	4.6	5.3	6.1
7/16	31	6.2	7.1	8.9
1/2	40	8.5	9.4	10.8
9/16	51	10.8	12.0	13.7
5/8	63	12.6	14.4	16.6
3/4	90	18.0	20.6	23.7
7/8	123	24.3	28.0	32.2
1	160	31.6	36.5	42.0
1 1/8	203	39.8	46.0	53.0
1 1/4	250	48.8	56.5	65.0
1 3/8	304	59.4	68.7	80.0
1 1/2	360	69.6	80.5	92.5
1 5/8	424	81.9	94.9	104.5
1 3/4	492	95.0	110.0	124.5
2	640	123.6	143.2	155.5
2 1/4	812	156.9	181.5	207.0
2 1/2	1,000	193.4	223.3	254.5
2 3/4	1,216	235.0	271.0	306.0

5-41. Wire Rope Safety Factors

Type of service	Minimum safety factor	Type of service	Minimum safety factor
Track cables -----	3.2	Haulage ropes -----	6.0
Guys -----	3.5	Derricks -----	6.0
Miscellaneous hoisting equipment ----	5.0	Small electric and air hoists -----	7.0

5-42. Properties of Chains

Normal size (diameter of stock in inches)	Approximate weight per 100 ft (pounds)	Safe working load *			
		Common iron (pounds)	High- grade iron (pounds)	Soft steel (pounds)	Special steel (pounds)
1/4	73	-----	1,530	1,800	2,620
5/16	110	-----	2,160	2,540	3,700
3/8	160	2,700	2,980	3,500	5,100
7/16	210	3,460	3,800	5,000	6,600
1/2	280	4,500	4,960	6,000	8,200
9/16	340	5,820	6,400	7,770	10,620
5/8	430	6,940	7,620	9,000	11,500
3/4	630	10,140	11,160	12,000	16,200
7/8	840	14,000	15,400	20,250	28,660
1	1,100	18,600	20,460	24,900	36,400
1 1/8	1,300	23,200	25,600	31,100	45,400
1 1/4	1,580	28,600	31,500	38,300	55,900
1 3/8	2,120	34,600	38,100	46,300	67,600
1 1/2	2,520	41,200	45,400	55,200	80,400
1 5/8	2,940	48,000	52,900	64,300	93,600
1 3/4	3,360	55,800	61,000	74,200	108,000
1 7/8	3,880	63,100	69,600	84,700	123,200
2	4,400	71,300	78,700	95,800	139,400

*If the type of iron in a chain is unknown, a safe working load (in short tons) is figured by multiplying 8 by the square of the diameter (in inches) of the metal stock on one side of any link. This applies only to chains made of ferrous metals.

5-43. Safe Working Loads of Slings

a. Stress or Tension. The stress or tension in each leg of a sling depends on the number of legs, the angles of the sling legs, and the total load. The total weight lifted is divided among the supporting sling legs and acts straight downward. As the horizontal angle of the leg decreases, the tension in the leg increases, since this tension is a function of the sine of the horizontal angle. Ordinarily, the hoisting line and the sling legs are of the same material and the same size, but this is not always the case. Sometimes the sling legs are of smaller material than the hoisting line, particularly when horizontal angles are large. The strength of the hoisting line determines the maximum lifting power of the combination. Since, preferably, the tension in each sling leg is less than or is equal to the tension in the hoisting line, the tension in each leg of a sling should be known. This can be computed by using the following formula:

$$T = \frac{WL}{NV}$$

or

$$T = \frac{W}{N \times \text{sine } A}$$

where

T = tension in the leg, in pounds (depending upon the horizontal angle of the leg, this tension could be considerably more than the total load being lifted)

W = weight lifted, in pounds

L = length of the leg, in inches

N = number of sling legs

V = vertical distance from the sling platform or sling bar to the hook, in inches

A = angle leg makes with the horizontal

b. Safe Working Loads. The safe working loads of rope, chain, and wire-rope sling combinations under various lift conditions are listed in *c* through *e* below. Due to the inherent loss of strength in the sling combinations (ties, splices, bends, etc.), appropriate reductions in the "straight pull" safe working loads have been made. The angles in each table are measured from the horizontal. In the unusual situations where triple slings are encountered, multiply quantities shown for double slings by one and a half.

c. Manila-Rope Slings. (Standard, three-strand manila-rope sling with a splice in each end.)

Circumference (inches)	Size	Single sling Vertical lift (pounds)	Double sling			Quadruple sling		
	Diameter (inches)		60° angle (pounds)	45° angle (pounds)	30° angle (pounds)	60° angle (pounds)	45° angle (pounds)	30° angle (pounds)
3/4	1/4	108	187	153	108	374	306	216
1 1/8	3/8	241	418	341	241	836	683	482
1 1/2	1/2	475	822	672	475	1,645	1,345	950
2	5/8	791	1,370	1,119	791	2,740	2,238	1,582
2 1/4	3/4	970	1,680	1,375	970	3,360	2,750	1,940
2 3/4	7/8	1,382	2,395	1,945	1,382	4,790	3,890	2,764
3	1	1,620	2,805	2,290	1,620	5,610	4,580	3,240
3 1/2	1 1/8	2,160	3,740	3,060	2,160	7,480	6,120	4,320
3 3/4	1 1/4	2,430	4,205	3,437	2,430	8,410	6,875	4,860
4 1/2	1 1/2	3,330	5,770	4,715	3,330	11,540	9,430	6,660
5 1/2	1 3/4	4,770	8,250	6,750	4,770	16,500	13,500	9,540
6	2	5,580	9,670	7,900	5,580	19,340	15,800	11,160
7 1/2	2 1/2	8,366	14,500	11,850	8,366	29,000	23,700	16,732
9	3	11,520	19,950	16,300	11,520	39,900	32,600	23,040

d. Chain Slings. (New wrought-iron chains.)

Link stock diameter (inches)	Single slings	Double sling			Quadruple sling		
	Vertical lift (pounds)	60° angle (pounds)	45° angle (pounds)	30° angle (pounds)	60° angle (pounds)	45° angle (pounds)	30° angle (pounds)
3/8	2,510	4,350	3,555	2,510	8,700	7,110	5,020
7/16	3,220	5,575	4,560	3,220	11,150	9,120	6,440
1/2	4,180	7,250	5,915	4,180	14,500	11,830	8,360
9/16	5,420	9,375	7,670	5,420	18,750	15,340	10,840
5/8	6,460	11,175	9,150	6,460	22,350	18,300	12,920
3/4	9,160	15,850	12,950	9,160	31,700	25,900	18,320
7/8	13,020	22,550	18,410	13,020	45,100	36,820	26,040
1	17,300	29,900	24,450	17,300	59,800	48,900	34,600
1 1/8	21,550	37,350	30,550	21,550	74,700	61,100	43,100
1 1/4	26,600	36,050	37,600	26,600	92,100	75,200	53,200
1 3/8	32,200	55,750	45,600	32,200	111,500	91,200	64,400
1 1/2	38,300	66,400	54,250	38,300	132,800	108,500	76,600
1 5/8	44,600	77,200	63,050	44,600	154,400	126,100	89,200
1 3/4	51,300	88,750	72,500	51,300	177,500	145,000	102,600
1 7/8	58,700	101,500	83,000	58,700	203,000	166,000	117,400
2	66,200	114,500	93,500	66,200	229,000	187,000	132,400

e. Wire Rope Slings. (New improved plow-steel wire rope.)

Diameter (inches)	Single slings	Double sling			Quadruple sling		
	Vertical lift (pounds)	60° angle (pounds)	45° angle (pounds)	30° angle (pounds)	60° angle (pounds)	45° angle (pounds)	30° angle (pounds)
1/4	1,096	1,899	1,552	1,096	3,798	3,105	2,192
5/16	1,690	2,925	2,390	1,690	5,850	4,780	3,380
3/8	2,460	4,260	3,485	2,460	8,520	6,970	4,920
7/16	3,560	6,170	5,040	3,560	12,340	10,080	7,120
1/2	4,320	7,475	6,105	4,320	14,950	12,210	8,640
9/16	5,460	9,450	7,725	5,460	18,900	15,450	10,920
5/8	6,650	11,500	9,400	6,650	23,000	18,800	13,300
3/4	9,480	16,400	13,400	9,480	32,800	26,800	18,960
7/8	12,900	22,350	18,250	12,900	44,700	36,500	25,800
1	16,800	29,100	23,750	16,800	58,200	47,500	33,600
1 1/8	21,200	36,700	30,000	21,200	73,400	60,000	42,400
1 1/4	26,000	45,000	36,800	26,000	90,000	73,600	52,000
1 3/8	32,000	55,400	45,250	32,000	110,800	90,500	64,000
1 1/2	37,000	64,000	52,340	37,000	128,000	104,700	74,000
1 5/8	41,800	72,400	59,200	41,800	144,800	118,400	83,600
1 3/4	49,800	86,250	70,500	49,800	172,500	141,000	99,600
2	62,300	107,600	88,050	62,300	215,200	176,100	124,600
2 1/4	82,900	143,500	117,400	82,900	287,000	234,800	165,800
2 1/2	101,800	176,250	144,000	101,800	352,500	288,000	203,600
2 3/4	122,500	212,000	173,500	122,500	424,000	347,000	245,000

5-44. Safe Loads on Hooks

The data below are keyed to figure 5-27.

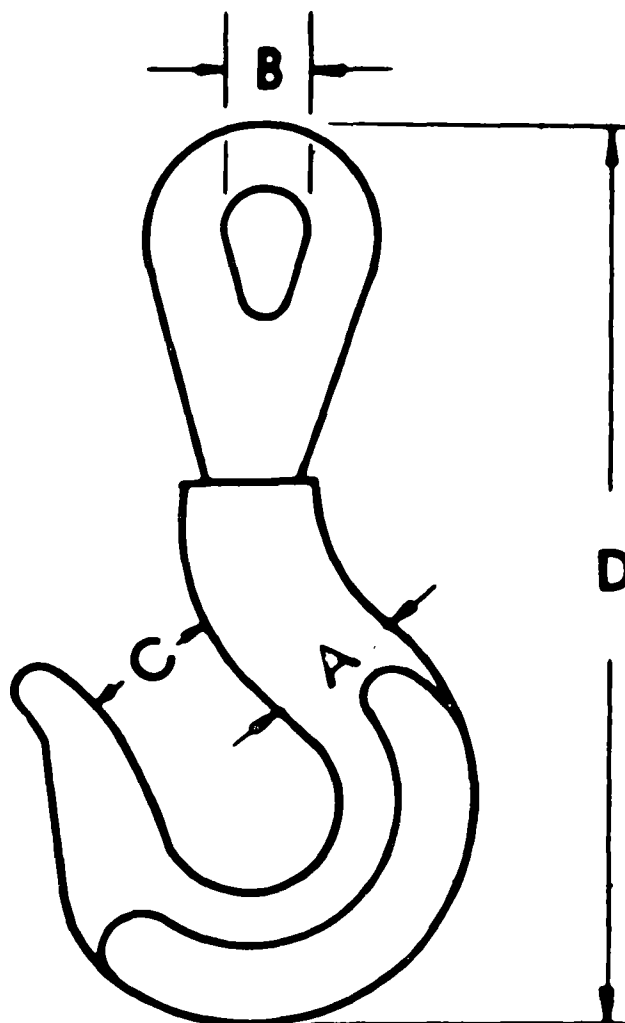


Figure 5-27. Cargo hook: critical dimensions.

Diameter of metal A (inches)	Inside diameter of eye B (inches)	Width of opening C (inches)	Length of hook D (inches)	Safe load on hook (pounds)
11/16	7/8	1 1/16	4 15/16	1,200
3/4	1	1 1/8	5 13/32	1,400
7/8	1 1/8	1 1/4	6 1/4	2,400
1	1 1/4	1 3/8	6 7/8	3,400
1 1/8	1 3/8	1 1/2	7 5/8	4,200
1 1/4	1 1/2	1 11/16	8 19/32	5,000
1 3/8	1 5/8	1 7/8	9 1/2	6,000
1 1/2	1 3/4	2 1/16	10 11/32	8,000
1 5/8	2	2 1/4	11 27/32	9,400
1 7/8	2 3/8	2 1/2	13 9/32	11,000
2 1/4	2 3/4	3	14 13/16	13,600
2 5/8	3 1/8	3 3/8	16 1/2	17,000
3	3 1/2	4	19 3/4	24,000

5-45. Minimum Groove Diameter of Sheaves and Drums

Rope diameter (inches)	Minimum groove diameter in inches for given rope constructions *			
	6 × 7	6 × 19	6 × 37	8 × 19
1/4	10 1/2	8 1/2	-----	6 1/2
3/8	15 3/4	12 3/4	6 3/4	9 3/4
1/2	21	17	9	13
5/8	26 1/4	21 1/4	11 1/4	16 1/4
3/4	31 1/2	25 1/2	13 1/2	19 1/2
7/8	36 3/4	29 3/4	15 3/4	22 3/4
1	42	34	18	26
1 1/8	47 1/4	38 1/4	20 1/4	29 1/4
1 1/4	52 1/2	42 1/2	22 1/2	32 1/2
1 1/2	63	51	27	39

*Rope construction is in strands times wires per strand.

5-46. Blocks and Tackle

a. Blocks and tackle consist of sheaves (pulleys) and ropes arranged so as to obtain a mechanical advantage. As shown in figure 5-28, the force P applied to the lifting end of the rope is much smaller than would be required to lift weight W without using block and tackle. P represents the pull on the rope that supports an equal part of the weight acting on the whole tackle.

b. Figure 5-29 depicts sample block and tackle riggings for manila and wire rope.

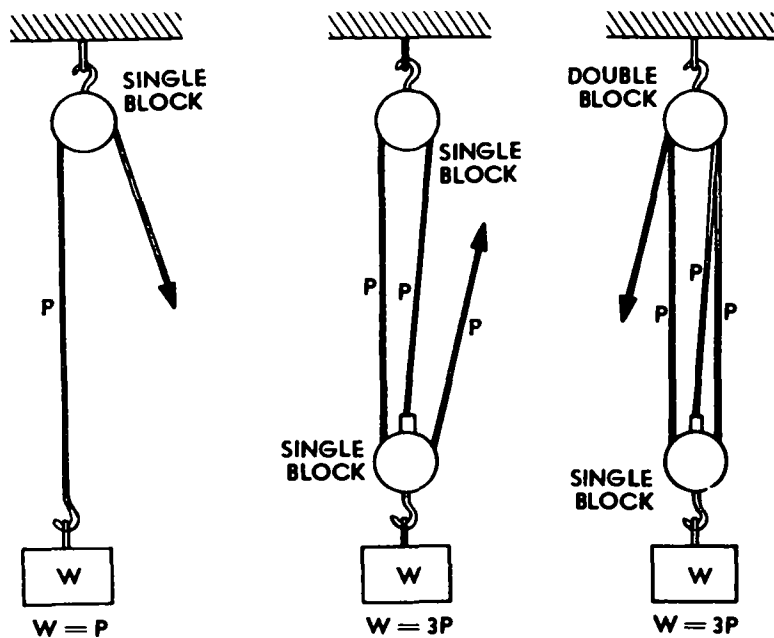
Single-, double-, and triple-sheave blocks are shown. Numbers on the illustration indicate the number of lines in the rigging.

(1) *Block and tackle rigging for manilla rope.* Permissible rope diameters are for new rope used under favorable conditions and normally with a safety factor of 4. As rope ages or deteriorates, the safety factor must be increased progressively to 8 when determining the size rope to be used. The smallest permissible rope diameter is given in inches and the lead line pull in pounds.

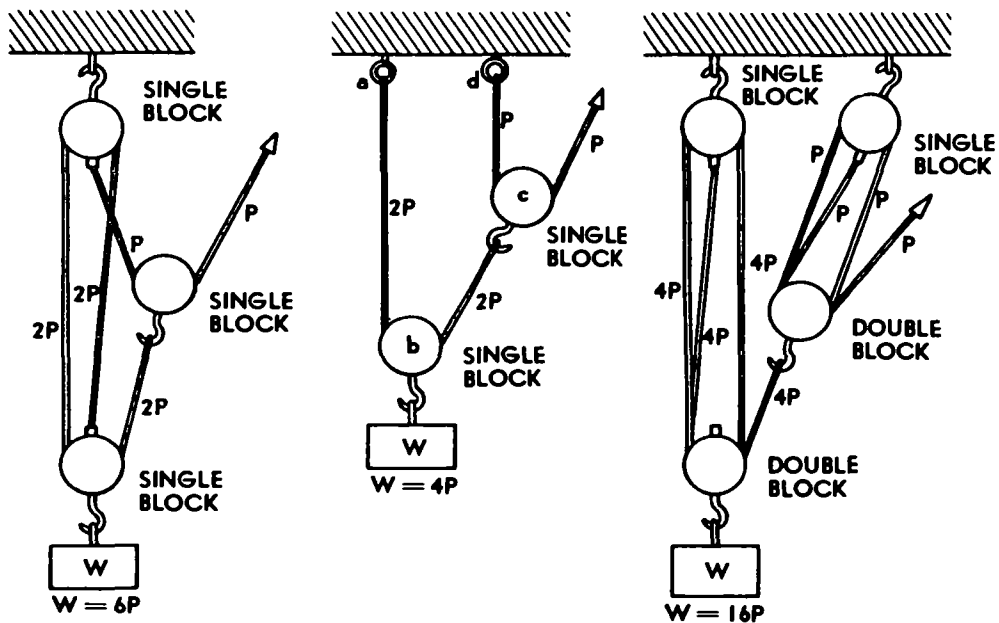
	Total number of sheaves in blocks				Load to be lifted (in tons)
	2 single	1 single, 1 double	2 double	1 double, 1 triple	
Rope	1/2	7/16	3/8	3/8	1/2
Pull	540	380	280	220	
Rope	3/4	5/8	1/2	1/2	1
Pull	1,100	740	560	445	
Rope	7/8	3/4	5/8	5/8	1 1/2
Pull	1,600	1,100	840	670	
Rope	1 1/8	7/8	3/4	5/8	2
Pull	2,200	1,500	1,120	890	
Rope	5/16	1 1/8	1	7/8	3
Pull	3,300	2,220	1,670	1,330	
Rope	1 1/2	1 1/4	1 1/8	1	4
Pull	4,440	2,960	1 5/16	1 1/4	6
Rope	-----	1 1/2	2,220	1,780	
Pull	-----	4,450	3,330	2,670	
Rope	-----	-----	1 5/8	1 1/2	8
Pull	-----	-----	4,450	3,560	

(2) *Block-and-tackle rigging for plow steel wire rope.* Permissible rope diameters are for rope in good condition (not excessively worn

or frayed). A safety factor of 6 is used. The smallest permissible rope diameter is given in inches and the lead line pull in pounds.



① SIMPLE TACKLE



② COMPOUND TACKLE

Figure 5-28. Examples of simple and compound tackle.

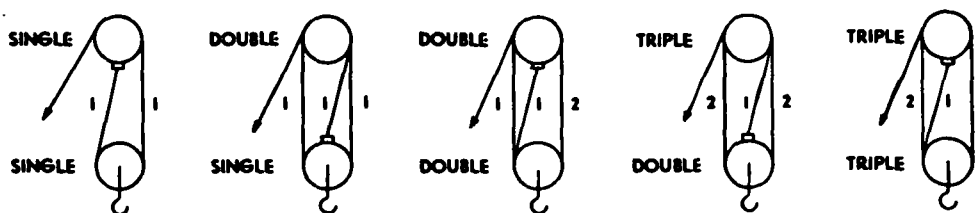


Figure 5-29. Sample block and tackle rigging for manila and wire rope.

		Total number of sheaves in blocks				Load to be lifted (in tons)
	2 single	1 single, 1 double	2 double	1 double, 1 triple	2 triple	
Rope	3/8	3/8	3/8	3/8	3/8	1
Pull	1,100	740	560	445	370	
Rope	1/2	3/8	3/8	3/8	3/8	2
Pull	2,200	1,480	1,100	880	740	
Rope	5/8	1/2	1/2	3/8	3/8	4
Pull	4,400	2,960	2,200	1,780	1,480	
Rope	3/4	5/8	5/8	1/2	1/2	6
Pull	6,600	4,440	3,400	2,660	2,200	
Rope	7/8	3/4	5/8	5/8	5/8	8
Pull	8,900	5,940	4,450	3,560	2,970	
Rope	1	7/8	3/4	5/8	5/8	10
Pull	11,100	7,410	5,550	4,450	3,710	
Rope	1 1/8	1	7/8	3/4	3/4	15
Pull	16,640	11,100	8,350	6,670	5,550	
Rope	1 1/2	1 1/8	1	7/8	7/8	20
Pull	22,200	14,800	11,100	8,900	7,400	

c. Recommended Sizes of Tackle Blocks.

The largest diameter of sheave for a given size of rope is preferred, when available, except that for 6 x 37 (6 strands, each with 37 wires) wire rope, the smallest diameter of sheave indicated below is suitable.

Wire rope		Manila rope	
Rope diameter (inches)	Outside diameter of sheave (inches)	Rope diameter (inches)	Length of block (inches)
3/8	6 to 8	1/2	4
1/2	8 to 10	5/8	6
5/8	10 to 12	3/4	6 to 7
3/4	12 to 16	7/8	7 to 8
7/8	14 to 18	1	8 to 10
1	14 to 20	1 1/8	8 to 10
		1 1/4	10 to 12
		1 1/2	12 to 14
		1 3/4	14 to 16

d. Effect of Block-and-Tackle Rigging on Strength of Wire Rope. Wire rope loses some of its tensile strength when it is passed around sheaves or drums. The amount of this loss depends upon variable factors, such as type and size of rope and diameter of sheave or drum. The table below shows percentage of reduction in the rated tensile strength for 6 x 7 and 6 x 19 plow-steel wire rope when passed around sheaves or drums of various diameters. Obviously, the 6 x 19 rope is more adaptable for this use (para 5-40), for the percentage of tensile-strength loss for a given size of 6 x 19 rope is much less than for the 6 x 7 rope. It should also be noted from the table that the percentage of tensile-strength loss varies inversely with the size of the sheave or drum.

Rope diameter (in.)	6 strands, each with 7 wires Sheave or drum diameter (ft)									6 strands, each with 19 wires Sheave or drum diameter (ft)								
	1	2	3	4	6	8	10	15	20	1	2	3	4	6	8	10	15	20
1/4										6.4	3.4	2.3	1.9	1.1				
9/32		4.5	3.0	2.2	1.5	1.1	.9	.6										
5/16		8.0	5.2	4.1	2.7	2.0	1.6	.9		8.9	4.5	3.2	2.4	1.6				
3/8		10.0	6.8	5.1	3.4	2.5	2.0	1.4		10.4	5.2	3.5	2.6	1.7				
7/16		13.7	9.1	6.9	4.6	3.4	2.7	1.9		11.8	5.9	3.8	3.0	1.9	1.5			
1/2		14.0	9.2	7.0	4.6	3.5	2.8	1.9		13.6	6.8	4.6	3.4	2.3	1.7	1.4		
9/16		16.3	11.0	8.2	5.5	4.1	3.3	2.2		15.6	7.8	5.4	3.9	2.7	2.0	1.6		
5/8		17.2	11.5	8.6	5.8	4.3	3.4	2.3		17.6	8.8	5.9	4.4	3.0	2.2	1.7		
3/4		20.5	13.7	10.3	6.8	5.1	4.1	2.7		20.6	10.3	7.0	5.1	3.5	2.6	2.0		
7/8			16.7	12.5	8.3	6.3	5.0	3.3		25.9	13.0	8.7	6.5	4.3	3.2	2.6	1.7	1.3
1			19.7	14.7	9.8	7.4	5.9	3.9			14.8	9.8	7.4	4.9	3.7	3.0	2.0	1.5
1 1/8				16.7	11.2	8.3	6.7	4.5			16.9	11.3	8.4	5.7	4.2	3.4	2.3	1.7
1 1/4				18.2	12.2	9.1	7.3	4.9			18.8	12.6	9.4	6.3	4.7	3.8	2.5	1.9
1 3/8				20.2	13.5	10.1	8.1	5.4			20.2	13.5	10.1	6.7	5.1	4.0	2.7	2.0
1 5/8				23.1	15.4	11.6	9.2	6.2				15.3	11.5	7.7	5.8	4.6	3.1	2.3
1 3/4												17.0	12.8	8.5	6.4	5.1	3.4	2.6
2												17.9	13.4	8.9	6.7	5.4	3.6	2.7
2 1/4													16.0	10.7	8.0	6.4	4.3	3.2
2 1/2													17.1	11.4	8.6	6.9	4.6	3.4
2 3/4														12.7	9.6	7.6	5.1	3.8
														14.1	10.6	8.5	5.6	4.2

5-47. Cubic Capacities, Weights, and Dimensions of Various Grab Buckets (Clamshells)

Capacity (cu yd)	Weight (lb)	Overall length of opened bucket (in.)	Overall length of closed bucket (in.)	Width of bucket (in.)	Capacity (cu yd)	Weight (lb)	Overall length of opened bucket (in.)	Overall length of closed bucket (in.)	Width of bucket (in.)
<i>General-purpose bucket with ore bowl</i>					1¼	3,900	94	80	44
½	1,700	72	48	36	1½	5,175	102	87	46
¾	2,700	85	60	40	1¾	5,300	108	92	46
1	3,200	99	67	40	2	5,800	101	87	52
1¼	3,400	99	67	47	2½	7,300	106	91	58
1½	4,400	108	74	50	3	9,000	111	97	64
1¾	4,600	108	74	54	<i>Electric single-rope grab bucket</i>				
2	5,500	108	76	62	¼	1,200	51	40	33
2½	7,400	120	84	63	¾	2,600	65	49	46
3	8,000	120	84	74	1	4,600	76	56	48
4	12,000	141	104	74	1¼	4,700	88	61	51
<i>General-purpose bucket</i>					1½	4,900	88	61	59
½	1,500	70	56	29	2	9,000	105	73	67
¾	3,000	83	71	37	2½	10,000	117	84	60
1	3,500	90	76	41	3	10,500	117	84	70

5-48. Data on Chain Hoists

Differential hoists						Worm-gear hoists					Spur-gear hoists *				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Capacity (tons)	Lift (ft)	Approx weight (lb)	Pull chain to lift full load (lb)	Ft of chain overhauled to lift full load 1 ft	Minimum distance between hooks (in.)	Lift (ft)	Approx weight (lb)	Pull on chain to lift full load (lb)	Ft of chain overhauled to lift full load 1 ft	Minimum distance between hooks (in.)	Lift (ft)	Approx weight (lb)	Pull on chain to lift full load (lb)	Ft of chain overhauled to lift full load 1 ft	Minimum distance between hooks (in.)
¼	6	22	72	18	17						8	58	50	12½	13
½	7	30	122	24	21	8	46	68	40	13	8	58	62	21	13
1	8	51	216	30	26	8	59	87	59	16	8	92	82	31	16
1½	8½	81	246	36	32	8	81	94	80	19	8	132	110	35	18
2	9	122	308	42	49	9	104	115	93	21	9	202	120	42	21
3	9½	180	557	38	44	10	187	132	126	25	10	209	114	69	32
4						10	221	142	155	29	10	299	124	84	37
5						12	331	145	195	31	12	411	110	126	45
6						12	310	145	252	33	12	411	130	126	46
8						12	416	160	310	36	12	500	135	168	49
10						12	578	160	390	45	12	610	140	210	54
12											12	855	260	252	54
16											12	1,041	270	336	62
20											12	1,350	280	420	70

*Spur-gear hoists of 12-, 16-, and 20-ton capacity have two operating chains. The pull on chains (column 14) and the amount of chain overhauled (column 5) is the total for the two chains.

Section V. TERMS**5-49. Stowage**

a. *Bale Cubic Capacity.* The space available for loading cargo, measured in cubic feet to the inside of the cargo battens on the frames

and to the underside of the beams. This measurement is used to compute the space available for general cargo.

b. *Broken Stowage.* The space lost in the

hold because of the contour of the ship and the shape of the cargo containers. A typical well-balanced general cargo vessel will have from 10 to 15 percent broken stowage; a complete load of vehicles will use only 60 to 70 percent of the available cargo space.

c. Grain Cubic Capacity. The maximum space available for cargo measured in cubic feet to the inside of the shell plating and to the underside of the deck plating of a ship. This measurement is used to compute cubic space available for loading bulk commodities.

d. Stowage Factor. The figure that denotes the number of cubic feet required to stow 1 long ton of cargo. This factor is obtained by dividing 2,240 pounds by the weight, in pounds, of a cubic foot of the commodity to be loaded.

5-50. Vessel

a. After Perpendicular. The vertical line through the intersection of the afterside of the sternpost with the load water plane.

b. Baseline. The intersection of the central longitudinal vertical plane of the ship with a horizontal plane through the top of the keel at the midship section. In some cases the keel line and baseline are the same.

c. Center of Buoyancy. The center of the molded volume of the vessel below the waterline. It is at the center of gravity of the displaced volume of water. It shifts its position, both vertically and horizontally, as the floating vessel tips. The total upward pressure of the water may be regarded as concentrated through the center of buoyancy, about which it balances. The center of buoyancy and the center of gravity of a ship floating in equilibrium in still water must be in the same vertical line.

d. Down by the Head and Down by the Stern. A vessel is down by the head when the bow draft is greater than the stern draft. When the stern draft is greater than the bow draft, the vessel is said to be down by the stern.

e. Draft and Draft Marks. Draft marks are

6-inch numerals painted on the bow and stern of a vessel to indicate the depth to which the bow and stern are submerged. The bases of the numerals mark the even foot marks.

f. Drag. When the stern is deeper in the water than the bow, the vessel is said to have a drag. The number of feet that the stern is lower is the amount of drag. (This is not to be confused with design drag.)

g. Forward Perpendicular. The vertical line through the intersection of the forward side of the stem with the load water plane.

h. Freeboard. A term used to express the vertical distance on the side of a vessel from the edge of the main deck line to the water. Freeboard (statutory) is the assigned distance measured amidships vertically from the upper (freeboard) deck to the upper edge of the load line (Plimsoll mark).

i. Full and Down. A vessel is said to be full and down when all available cubic space has been utilized (full) and sufficient weight is aboard to submerge the vessel to her legal loadline (down).

j. Hogging. A vessel is said to be hogging when the weight at both the bow and the stern is greater than at the midships section, thus making the vessel tend to arch up or "hog" amidships.

k. Keel Line. The line of the fore and aft member running along the centerline of the ship at its lowest part.

l. Load Waterline (LWL). The line, viewed horizontally, that represents the intersection of the ship's form with the plane of the surface of the water (load water plane) when the ship is floating with her designed load on board.

m. Loadline or Plimsoll Mark. The loadline or Plimsoll mark amidships on the hull of a vessel denotes the maximum draft to which the vessel may be loaded for a particular voyage, depending upon the area to be traveled and the season of the year. The top of the line AB (line S) in figure 5-30 indicates the summer loadline. For ease of observation, the cir-

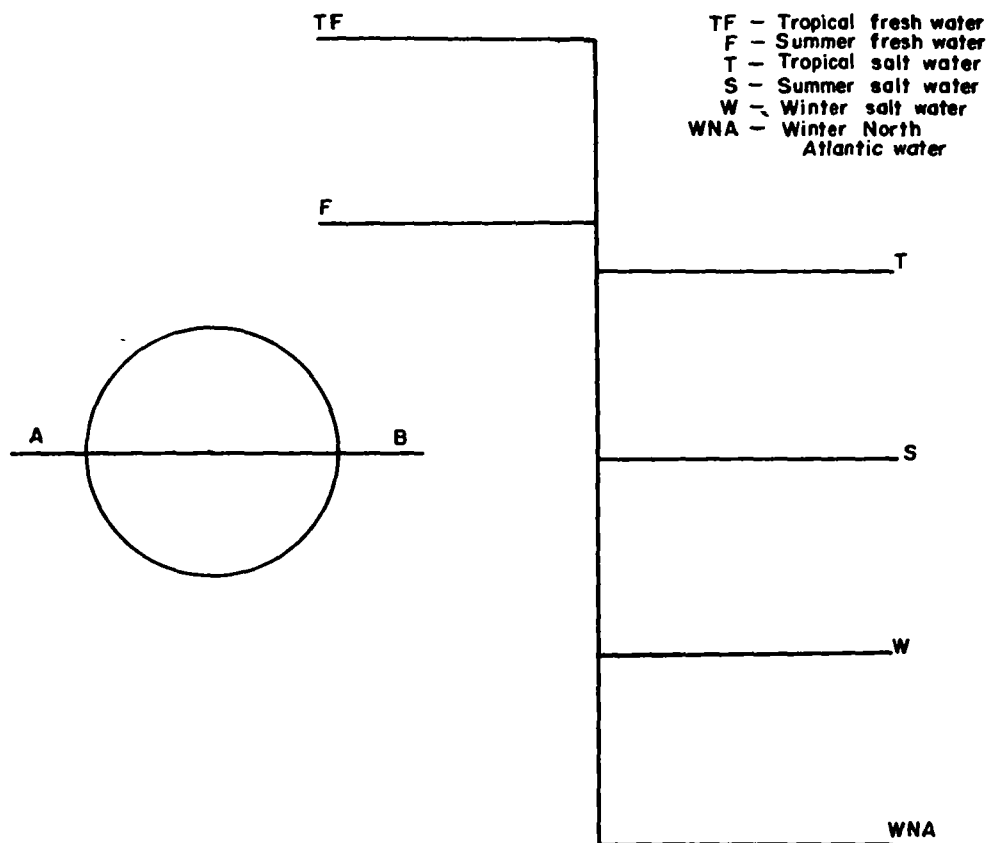


Figure 5-30. Loadline or Plimsoll mark.

clad line AB usually is placed next to the Plimsoll mark on a vessel that habitually loads in the same kind of water.

n. Midships Section. The vertical transverse (athwartship) section located at the midpoint between the forward and after perpendiculars. Usually this is the largest section of the ship.

o. Sagging. The opposite of hogging.

p. Stiff Ship. A ship is said to be "stiff" when it has excessive weight in the lower hold and insufficient weight in the 'tween decks. A stiff ship has a tendency to snap back from a roll in a sudden, jarring manner.

q. Tender Ship. A vessel with excessive weight in the 'tween decks and insufficient weight in the lower hold. A tender ship has a long, slow roll and a tendency to capsize.

r. Vessel Stowage Factor. This factor is the bale cubic capacity less estimated lost space divided by the cargo capacity tonnage less estimated weight of the deck cargo. It is the stowage factor for a particular vessel and cargo and should be employed to fully utilize both the cargo space and weight capacity of a vessel. An example of use is shown in (1) and (2) below.

(1) *Example problem.* Determine the ideal cargo for a Liberty ship with a 400,000-cubic-foot capacity after lost space is deducted and with a cargo capacity tonnage (less deck-load) of 8,000 long tons.

(2) *Solution:*

$$\text{Vessel stowage factor} = \frac{400,000}{8,000} = 50 \text{ cubic feet per long ton}$$

A cargo of 50 cubic feet per long ton would fully utilize both space and weight capacity of

the vessel and would therefore be the ideal cargo. A cargo weighing more per unit of volume would make weight the limiting factor, thus wasting some cargo space. A cargo weighing less per unit of volume would make volume the limiting factor, thus wasting some of the weight capacity of the vessel.

5-51. Tonnage

a. Canal Tonnage (Panama or Suez). Derived from formulas of measurement prescribed by the respective canal authorities for the assessment of tolls. Space exemptions allowed are not uniform for the two canals, and, as a consequence, ships must carry a certificate for each.

b. Cargo Deadweight Tonnage. The total cargo and passenger capacity of a ship expressed in long tons. The figure is computed by deducting the weight of the fuel, water, stores, dunnage, and other items necessary for a voyage from the deadweight tonnage of the vessel.

c. Deadweight Tonnage. The carrying capacity of a ship in long tons. It represents the difference between the displacement light and the displacement loaded to the maximum draft allowed by law.

d. Displacement Ton. A unit of weight equal to the volume of a long ton of sea water (35 cu. ft.). Used in computing the displacement of vessels.

e. Displacement Tonnage, Light. The weight of the ship in long tons excluding cargo, passengers, fuel, water, stores, dunnage, and other items necessary for use on a voyage.

f. Displacement Tonnage, Loaded. The weight of the ship in long tons, including cargo, passengers, fuel, water, stores, dunnage, and such other items as necessary for use on a voyage.

g. Equipment Tonnage. This is the tonnage arrived at from certain dimensions which take into consideration the exposed surfaces of the vessel both above and below water. It very closely approximates the gross tonnage in a vessel of ordinary construction. Equipment

tonnage is used primarily to determine the size of anchors, chains, hawsers, and other ship's gear.

h. Gross Ton. A unit of capacity of 100 cubic feet (2.8317 cubic meters) used for ascertaining the legal or registered tonnage of vessels. Also called a *register* or *vessel ton*.

i. Gross Tonnage. The entire internal cubic capacity of a ship expressed in gross tons. Also referred to as gross register tonnage.

j. Long Ton. A unit of weight, 2,240 pounds avoirdupois (1016.106 kg).

k. Manifest Ton. The unit at which cargo is billed or manifested when the carrier has the option to assess freight charges on the basis of a ton weight, or a ton measurement, whichever affords the greater revenue. Also known as a *revenue ton*.

l. Measurement Ton. A unit of volume for cargo computed at 40 cubic feet. Also called a *freight ton*, *stevedore ton*, or *ship ton*.

m. Net Tonnage. The payload spaces remaining after deduction from the gross tonnage of space for the crew, powerplant, fuel, and operation of the vessel. Net tonnage is expressed in gross tons and is sometimes referred to as *net register tonnage*.

n. Short Ton. A unit of weight of 2,000 pounds (907.2 kg).

5-52. Shipping

a. Bareboat Charter. A charter in which the bare ship is chartered without crew; the charterer, for a stipulated sum, taking over the vessel with a minimum of restrictions. Also called *demise charter*, *barepole charter*, or *barehull charter*.

b. Berth Terms. A form of charter under which the carrier is responsible for loading and unloading the cargo; these terms apply almost universally to partial cargoes.

c. Charter Party. An agreement by which a shipowner agrees to place an entire ship, or a part of it, at the disposal of a merchant or other person for the conveyance of goods,

binding the shipowner to transport them to a particular place, for a sum of money which the merchant undertakes to pay as freight for their carriage. Sometimes referred to simply as charter. Charters are either time, voyage, or demise (bareboat).

d. Free Alongside Ship (FAS). Trade term which implies that the goods should be placed by the shipper within reach of the ship's tackle in a condition fit for shipment. The exact meaning of the word "alongside" is sometimes determined by the custom of the port, but is generally a pure question of fact.

e. Free In and Out (FIO). A chartering term that means that the owner who charters his ship is responsible for all the usual costs of ship management with the exception of loading and discharging cargo and of putting the vessel in drydock if required to do so by the charterer.

f. Free of Address (FOA). A chartering clause which means that no address charges shall be made on the freight at the port of discharge.

g. Free of Turn. A chartering term which means that a steamer's time will commence to count for loading or discharging from her arrival, whether there is a berth available or not.

h. Free on Board (FOB). A mercantile expression used in sale contracts which denotes that the goods have to be delivered by the shippers on board the vessel at a particular place, free of all charges.

i. Free Time. Chartering term which denotes the duration of time between the moment that the notice of readiness has been handed to the charterers and the beginning of lay days.

j. Freight Forward. A term which denotes that under the transportation agreement freight is payable by the consignee at port of destination. The opposite of *freight prepaid*.

k. Lay Days. Days allowed by charter party for loading and/or discharging cargo.

5-53. Tonnage Conversion Factors

a. General. Measurement ton cargo factors are utilized to compute ocean transportation requirements and required shipping capability in support of current and contingency plans and operations. This paragraph contains conversion factors to be utilized in converting the weight of initial equipment and other cargo commodities shown below to cubic measurement for ocean shipping purposes.

b. Definitions.

(1) *Initial equipment.* Prescribed TA and TOE equipment deployed with a unit.

(2) *MSTS Commodities.*

(a) *General cargo.* Any commodity other than aircraft, ammunition and explosives, reefer, and special cargo as each is defined herein.

(b) *Special cargo.* All wheeled and tracked vehicles and any commodity which weighs more than 10,000 pounds or measures 35 feet or more in any dimension.

(c) *Ammunition and explosives.* Bombs fuses, TNT blocks, caps, handgrenades, powder, dynamite, or any other commodity which must be allocated isolated and specialized stowage space in a cargo ship or be carried in an ammunition ship or be loaded and discharged at an ammunition pier because of its highly explosive nature. Does not include small arms ammunition.

(d) *Reefer.* Perishable commodities such as meats, vegetables, fruits, butter, eggs, and poultry, which require refrigerated (chill or freeze) storage at prescribed temperatures while in transit to prevent deterioration or loss. Does not include semiperishable cargo stored in ventilated holds.

(e) *Aircraft.* Whole aircraft or complete fuselages whether or not engines are installed. Does not include repair parts, engines, aircraft repair supplies, or boxed aircraft.

c. Factors. Factors are provided for the three major weight categories, i.e., short ton (2,000 pounds), long ton (2,240 pounds) and metric ton (2,204.6 pounds).

Cargo type	Measurement tons (40 cubic feet) per:		
	Short ton	Long ton	Metric ton
Initial equipment -----	4.20	4.70	4.63
MSTS Commodities:			
General -----	2.32	2.60	2.56
Special -----	4.73	5.30	5.21
Ammunition -----	1.04	1.17	1.15
Reefer -----	1.86	2.08	2.05
Aircraft -----	53.70	60.14	59.19
Weighted Averages:			
All MSTS Com-			
modities (Ex-			
cluding aircraft).	2.5	2.8	2.76
All MSTS Commod-			
ities (Including			
aircraft) -----	2.6	2.9	2.87

d. *Application.* For estimating ocean shipping requirements, users should convert weight to measure by applying the appropriate conversion factor shown above to the quantity of each type cargo involved. Only when this is not possible should the weighted average of all commodities be used. It should be noted that because of the large number of aircraft carried above deck the measurement ton is not an accurate measure of shipping space for movement purposes. Therefore, aircraft should be treated separately, if possible, and a weighted average is provided for this purpose.

5-54. Computation of Stowage Factor

a. A stowage factor is a relation of cube to weight. As applied to cargo, it is the ratio

of the number of cubic feet of space occupied by the cargo to the weight of the cargo in long tons. The units in which a stowage factor is expressed are stated as cubic feet per long ton.

b. The usual method of obtaining a stowage factor is—

(1) Determine the number of long tons of cargo by dividing 2240 pounds (1 long ton) into the number of pounds of cargo. The quotient of this division is then divided into the cubic foot measurement of the cargo, the answer of which equals the stowage factor.

Example:

1000 cartons of rations weigh 40,320 pounds
18 long tons

2240 / 40,320

125 (stowage factor)

18 (long tons) / 2,250 (cubic measurement)

(2) The above computations can be eliminated by using the stowage factor chart below. Using the figures appearing in (1) above, locate 40,320 in the "pounds" column. You will note that 40,320 pounds equal 18 long tons. Move along the same horizontal line to the right until 2,250 (the measurement of the cargo in cubic feet) is located. Move to the top of this column to find the cargo stowage factor, in this instance 125.

STOWAGE FACTOR CHART

STOWAGE FACTOR CHART

Section VI. MISCELLANEOUS

5-55. Approximate Sailing Distances in Nautical Miles

Distances shown below are in nautical miles

because international distances over water are normally expressed in this unit of measure. To convert to statute miles, multiply by 1.15155; to convert to kilometers, multiply by 1.85325.

<i>Distance from—</i>	<i>Distance to—</i>						
	<i>Boston</i>	<i>New York</i>	<i>Charleston</i>	<i>New Orleans</i>	<i>Los Angeles</i>	<i>San Francisco</i>	<i>Seattle</i>
Caribbean and South America:							
Argentina, Buenos Aires ---	5,800	5,900	5,800	6,300	^a 8,300	^a 8,700	^a 9,600
Brazil, Rio de Janeiro -----	4,700	4,800	4,700	5,200	^a 7,300	^a 7,600	^a 8,400
Chile, Valparaiso -----	^a 4,800	^a 4,600	^a 4,200	^a 4,100	4,800	5,100	5,900
Panama, Panama -----	2,200	2,200	1,600	1,400	2,900	3,200	4,000
Puerto Rico, San Juan -----	1,500	1,400	1,100	1,500	^a 3,900	^a 4,300	^a 5,100
Trinidad, Port of Spain -----	2,000	1,900	1,700	2,100	^a 4,100	^a 4,400	^a 5,300
Europe:							
Belgium, Antwerp -----	3,200	3,400	3,800	4,800	^a 7,700	^a 8,000	^a 8,800
France:							
Bordeaux -----	3,000	3,200	3,700	4,700	^a 7,600	^a 7,900	^a 8,700
Brest -----	2,900	3,100	3,500	4,500	^a 7,400	^a 7,700	^a 8,500
Le Havre -----	3,000	3,200	3,600	4,600	^a 7,500	^a 7,800	^a 8,600
Norway, Oslo -----	3,900	4,100	4,400	5,300	^a 8,200	^a 8,600	^a 9,400
United Kingdom:							
Belfast -----	2,900	3,000	3,400	4,400	^a 7,200	^a 7,500	^a 8,300
Liverpool -----	3,000	3,200	3,700	4,700	^a 7,600	^a 7,900	^a 8,700
Southampton -----	3,000	3,200	3,600	4,600	^a 7,500	^a 7,800	^a 8,600
Far East:							
China, Shanghai -----	^a 10,800	^a 10,600	^a 10,800	^a 10,000	5,700	5,400	5,100
Formosa, Keelung -----	^a 10,932	^a 10,750	^a 10,339	^a 10,176	5,858	5,570	5,310
Hong Kong -----	^a 11,400	^a 11,200	^a 10,800	^a 10,600	6,400	6,000	5,700
Japan, Yokohama -----	^a 9,900	^a 9,600	^a 9,500	^a 9,100	4,800	4,500	4,200
Korea, Pusan -----	^a 10,547	^a 10,365	^a 9,954	^a 9,791	5,229	4,914	4,649
Okinawa, Naha -----					6,000	5,682	5,360
Vietnam, Saigon -----	^b 10,586	^a 12,085	^b 11,190	^a 11,444	7,200	6,882	6,573
India-Burma-Pakistan:							
Burma, Rangoon -----	^b 9,600	^b 9,800	^b 10,200	^b 11,200	9,000	8,600	8,200
					^a ^b 13,900	^a ^b 14,200	^a ^b 15,000
India:							
Bombay -----	^b 8,000	^b 8,200	^b 8,600	^b 9,500	^a ^b 12,200	^a ^b 12,600	^a ^b 13,400
					10,300	9,800	9,500
Calcutta -----	^b 9,600	^b 9,800	^b 10,200	^b 11,200	^a ^b 13,900	^a ^b 14,200	^a ^b 15,000
					9,500	9,000	8,700
Pakistan, Karachi -----	^b 7,800	^b 8,200	^b 8,400	^b 9,300	10,700	10,200	9,900
					^a 12,000	^a 12,400	^a 13,200
Mediterranean:							
Algeria, Algiers -----	^b 3,400	^b 3,600	^b 4,000	^b 5,000	^a ^b 7,700	^a ^b 8,000	^a ^b 8,800
France, Marseilles -----	^b 3,700	^b 3,900	^b 4,300	^b 5,300	^a ^b 8,000	^a ^b 8,200	^a ^b 9,000
Greece, Piraeus -----	^b 4,500	^b 4,700	^b 5,100	^b 6,100	^a ^b 7,800	^a ^b 8,100	^a ^b 8,900
Italy:							
Leghorn -----	^b 3,900	^b 4,100	^b 4,500	^b 5,500	^a ^b 8,200		
Naples -----	^b 4,000	^b 4,200	^b 4,600	^b 5,600	^a ^b 8,300	^a ^b 8,500	^a ^b 9,300
Lebanon, Tripoli -----	^b 4,100	^b 4,300	^b 4,700	^b 5,700	^a ^b 8,400	^a ^b 8,600	^a ^b 9,400
Straight of Gibraltar -----	3,000	3,200	3,600	4,600	^a 7,300	^a 7,500	^a 8,300
Middle East:							
Aden -----	^b 6,300	^b 6,500	^b 6,900	^b 7,900	^a 10,600	^a 10,900	^a 11,700
Egypt, Port Said -----	^b 4,900	^b 5,110	^b 5,500	^b 6,500	^a 9,200	^a 9,500	^a 10,300
Iraq, Basra -----	^b 8,300	^b 8,500	^b 8,900	^b 9,800	^a 12,600	^a 12,900	^a 13,700
Turkey, Istanbul -----	^b 4,800	^b 5,000	^b 5,400	^b 6,400	^a 9,100	^a 9,400	^a 10,200

See footnote at end of table.

Distance from—	Distance to—						
	Boston	New York	Charleston	New Orleans	Los Angeles	San Francisco	Seattle
Middle Pacific:							
Hawaii, Honolulu	" 6,900	" 6,700	" 6,300	" 6,100	2,200	2,100	2,400
Mariana Islands, Guam	" 10,200	" 10,000	" 9,600	" 9,400	5,600	5,100	4,900
Marshall Islands, Kwajalein	" 9,200	" 9,000	" 8,600	" 8,400	4,200	4,410	4,500
North Atlantic:							
Bermuda, Hamilton	700	700	800	1,700	" 4,600	" 4,900	" 5,800
Greenland, Ivigtut	1,700	1,900	2,400	3,400	" 6,500	" 6,800	" 7,600
Iceland, Reykjavik	2,300	2,500	3,000	4,000	" 7,100	" 7,400	" 8,200
Newfoundland, St. Johns	900	1,100	1,700	2,600	" 5,700	" 6,000	" 6,800
North Pacific:							
Alaska, Dutch Harbor	" 7,400	" 7,300	" 6,900	" 6,700	2,400	2,100	1,700
Southwest Pacific:							
Australia:							
Brisbane	" 9,900	" 9,600	" 9,300	" 9,100	6,300	6,200	6,500
Melbourne	" 10,100	" 9,900	" 9,500	" 9,400	7,000	7,000	7,300
Indonesia, Djakarta	" 10,200	" 10,400	" 10,800	" 12,000	8,100	7,600	7,300
Malaya, Singapore	" 9,900	" 10,100	" 10,500	" 11,500	7,900	7,500	7,100
New Guinea, Finschafen	" 10,200	" 10,000	" 9,600	" 9,400	6,100	5,900	6,000
Philippines, Manila	" 11,600	" 11,300	" 11,000	" 10,800	7,520	7,164	6,200
Union of Soviet Socialist Republics:							
Archangel	4,000	4,200	4,800	5,800	" 8,800	" 9,200	" 10,000
Murmansk	3,700	3,800	4,400	5,400	" 8,500	" 8,900	" 9,700
Vladivostok	" 9,500	" 9,300	" 8,900	" 8,700	5,000	4,600	4,400
United States:							
Boston		200	900	2,000	" 5,100	" 5,400	" 6,200
Charleston	900	600		1,200	" 4,500	" 4,900	" 5,600
Los Angeles	" 5,100	" 4,900	" 4,500	" 4,300		400	1,100
New Orleans	2,000	1,900	1,200		" 4,300	" 4,700	" 5,500
New York	200		600	1,700	" 4,900	" 5,300	" 6,000
San Francisco	" 5,400	" 5,300	" 4,900	" 4,700	400		800
Seattle	" 6,200	" 6,000	" 5,600	" 5,500	1,100	800	

^a Via Panama Canal.

^b Strait of Gibraltar.

5-56. United States Buoyage System (fig. 5-31)

a. Buoys are wooden or metal floats of various shapes, sizes, and colors anchored to the bottom of harbors, bays, rivers, and channels. They are the road markers of the sea. The primary function of a buoy is to warn the mariner of some danger, obstruction, or change in the contours of the sea bottom, and to delineate the channels leading to various points, so that he may avoid the dangers and continue his course safely. The different types of buoys are identified by size, shape, coloring, numbering, and the signaling devices with which they are equipped. They are marked on charts so that the mariner can plot his course to avoid the potential hazards indicated.

b. The waters of the United States are

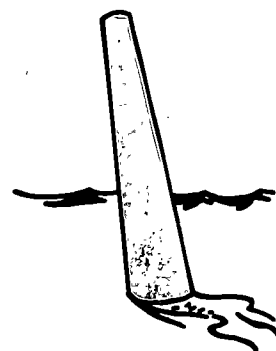
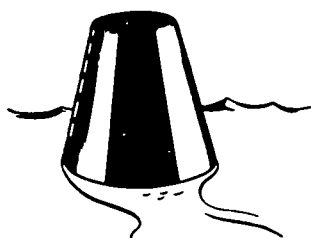
marked for safe navigation by the lateral system of buoyage. This system employs a simple arrangement of colors, shapes, numbers, and light characteristics to show the side on which a buoy should be passed when proceeding in a given direction. The characteristics are determined by the position of the buoy with respect to the navigable channels as the channels are entered from seaward. Not all channels lead from seaward, arbitrary assumptions have been applied at times in order to keep the system consistent, and the operator should consult the aids shown on his chart to determine the seaward direction of a channel. Some mariners use the expression "red right returning" to keep in mind the proper position of these buoys in relation to their vessels. The principal types of buoys are described below:

**CAN BUOY**

Marking Port Side of
Channel From Seaward

**NUN BUOY**

Marking Starboard Side of
Channel From Seaward

**SPAR BUOY****MIDCHANNEL OR
FAIRWAY MARKER****BUOY MARKING
OBSTRUCTION**

If Top Band Is Red, Keep Buoy To
Starboard. If Top Band Is Black,
Keep Buoy To Port.

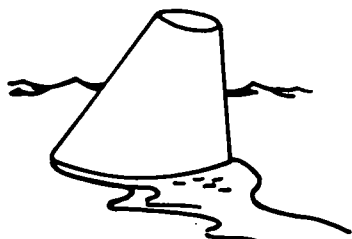
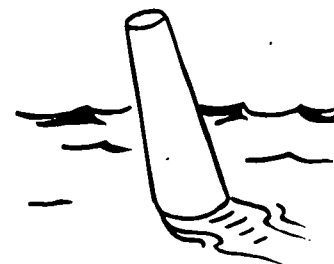
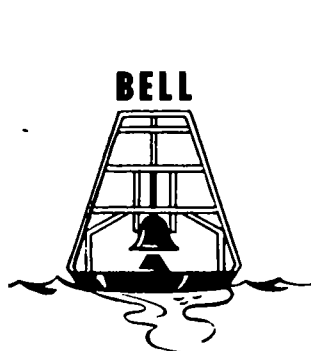
**BUOY MARKING
DREDGING AREA****QUARANTINE
ANCHORAGE****FISH TRAP OR
NET MARKER****ANCHORAGE
AREA****BELL****LIGHTED****WHISTLE**

Figure 5-31. Buoyage system used in United States Waters.

(1) A spar buoy is usually a large log, trimmed and appropriately painted; it may also be constructed of steel plates, joined to form a slim cylinder. The shape of a spar buoy has no significance: it is used for any purpose. Coloring reveals the particular meaning of the buoy.

(2) A can buoy is constructed of steel plates and its shape is similar to that of an ordinary tin can. Normally it is used to designate the port side (entering from seaward), but may be used to mark the middle of a channel, a junction, or an obstruction. Color indicates the particular meaning. A can buoy is never used to mark the starboard side of a channel when entering from seaward.

(3) A nun buoy is also constructed of steel plates and has a conical top. It is normally used to mark the starboard side of the channel, but may also be used for midchannel, junction, or obstruction marking; the color denotes the particular purpose. A nun buoy is never used on the port side of a channel.

(4) A lighted buoy is a metal float on which is mounted a short skeleton tower with a lantern at the top. It has no shape significance; its purpose is indicated by color.

(5) Bell buoys, gong buoys, and whistle buoys are metal floats with sound equipment installed. No special significance is attached to their shapes.

c. All United States buoys are painted with distinctive colors to indicate their purpose or the side on which they should be passed when entering from seaward.

(1) A black buoy marks the port side of a channel, or the location of obstructions which must be passed by keeping the buoy on the portside of the vessel when entering from seaward. It displays white or green lights at night.

(2) A red buoy marks the starboard side of a channel, or the location of obstructions which must be passed by keeping the buoy on the starboard side. It displays white or red lights at night.

(3) A red and black horizontally banded buoy marks a junction in the channel or an

obstruction which may be passed on either side. If the topmost band is black, the preferred channel will be followed by keeping the buoy on the port side when proceeding from seaward; if the topmost band is red, the preferred channel will be followed by keeping the buoy on the starboard side. This buoy may have white, red, or green lights.

(4) A black and white vertically striped buoy marks the fairway or midchannel, and should be passed close to, on either side. It displays a white light at night.

(5) Special-purpose buoys have distinctive colors and are usually spar buoys. They reveal the locations or anchorage areas, dredging operations, etc.

(6) Buoys used on the Intracoastal Waterway are similar to the preceding ones, but are characterized by a yellow border, and are discussed and illustrated in CG-193.

d. Buoys indicating the starboard side are marked with even numbers; those indicating the port side are marked with odd numbers. Midchannel, junction, and special-purpose buoys are not numbered, but may be lettered for identification. An example is the East Rockaway Inlet Bell Buoy, which carries black and white vertical stripes and the letters ER-ER standing for the station name.

e. Usually only buoys in key spots have lights; some unlighted buoys have reflectors which may be white, red, or green, and have the same significance as lights of the same colors. Black buoys have green or white lights; red ones have red or white lights. Midchannel buoys use white only, while obstruction (junction) buoys use the appropriate color to reveal the preferred channel. Channel buoy lights are usually slow flashing (not over 30 flashes per minute). If they mark important turns or dangerous areas, they will be quick flashing with 60 or more flashes per minute. Red and black horizontally banded buoys have interrupted quick flashing lights—a series of quick flashes with dark intervals of about 4 seconds between series. Midchannel buoys have short-long flashing lights—groups consisting of a short flash and a long flash repeated at the rate of about eight per minute.

5-57. Storm Warning Signals

(fig. 5-32)

a. Small Craft Warning. One red pennant displayed by day or a red light over a white at night indicates winds up to 38 miles an hour (61 kilometers per hour) (33 knots) and/or sea conditions dangerous to small craft operations.

b. Gale Warning. Two red pennants displayed by day or a white light above a red light at night indicate winds ranging from 39 to 54 miles an hour (63 to 87 kilometers per hour) (34 to 48 knots).

c. Whole Gale Warning. A single square red flag with a black center displayed during daytime or two red lights at night indicate winds ranging from 55 to 73 miles an hour (89 to 118 kmph) (48 to 63 knots).

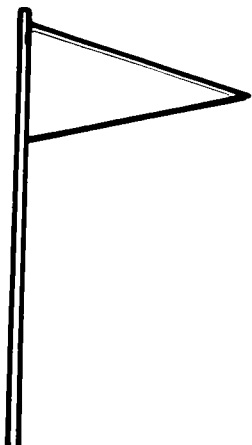
d. Hurricane Warning. Two square red flags with black centers displayed by day or a white light between two red lights at night indicate winds 74 miles per hour (119 kmph) (64 knots) and above.

5-58. Beaufort's Scale

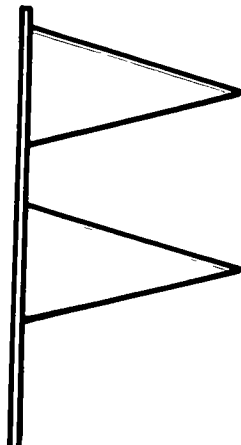
Beaufort No.	Description of wind	Miles per hour (statute)	Miles per hour (nautical)
0	Calm	Less than 1 ..	Less than 1
1	Light air	1-3	1-3
2	Light breeze ..	4-7	4-6
3	Gentle breeze ..	8-12	7-10
4	Moderate breeze.	13-18	11-16
5	Fresh breeze ..	19-24	17-21
6	Strong breeze..	25-31	22-27
7	Moderate gale ..	32-38	28-33
8	Fresh gale	39-46	34-40
9	Strong gale	47-54	41-47
10	Whole gale	55-63	48-55
11	Storm	64-75	56-65
12	Hurricane	Above 75	Above 65

DAYTIME SIGNALS

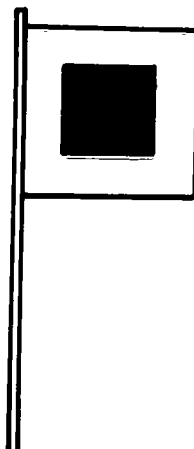
SMALL CRAFT



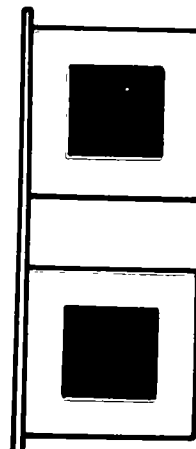
GALE



WHOLE GALE

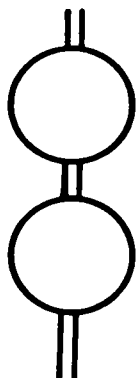


HURRICANE

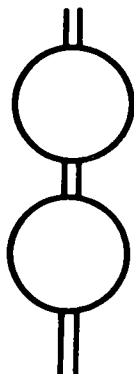


NIGHT SIGNALS

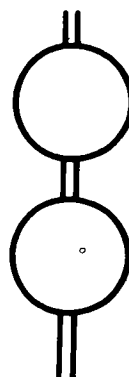
SMALL CRAFT



GALE



WHOLE GALE



HURRICANE

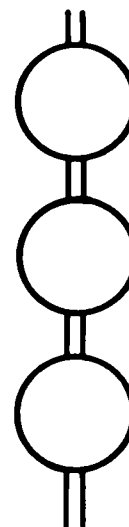


Figure 5-32. Storm warning signals.

CHAPTER 6

PLANNING

Note. The formats included in this chapter have been appropriately condensed for the transportation planner. Normally, these formats apply only in the initial stages of planning. See FM 101-5 for more detailed information and AR 380-5 for classification procedures.

Section I. ORDERS AND STANDING OPERATING PROCEDURES

6-1. Operation Order

COPY No. _____

Issuing headquarters

Place of issue (may be in code)

Date-time group of signature

Message reference number

Operation order: Type and serial number. (Type is usually indicated in combined or joint operations but omitted within a single service. When required, a code title may also be included.)

References: Maps, charts, and other relevant documents.

Time zone: Used throughout the order; if unnecessary, omit.

Task organization: Task subdivisions or tactical components of the command and names and ranks of the commanders. (When a task organization is not listed, this information is included in paragraph 3 or in an annex.)

1. **SITUATION.** General information on the overall situation required to understand current circumstances.

a. **Enemy forces.** Composition, disposition, location, movement, estimated strength, identification and capability.

b. **Friendly forces.** Information on forces, other than those covered by this order, which may directly affect actions of subordinates.

c. **Attachments and detachments.** Units attached to or detached from the issuing unit (if not shown under task organization) and effective times. (If shown under task organization, appropriate reference is listed here.)

2. **MISSION.** A clear, concise statement of the task to be accomplished by the command and purpose of the task.

3. EXECUTION.

a. First subparagraph. Concept of the operation, including the commander's general plan for development and phasing of the operation, use of fire support, instructions on preparatory fires, and designation of unit making the main effort.

b. Following subparagraphs. Specific tasks of each element charged with executing tactical missions, including the organization for combat (if not given under task organization).

c. Final subparagraph "Coordinating Instructions." Details of coordination and control measures applicable to the command as a whole, in addition to instructions necessary for coordination or the general conduct of the operation and which apply to two or more elements if repetition in preceding subparagraphs would be cumbersome.

4. ADMINISTRATION AND LOGISTICS. Administrative instructions and method of providing combat service support for the operation, including allocation of critical supply items and special ammunition loads. Reference is made to any administrative order in effect or being issued separately. Subparagraphs following the sequence of the administrative order are included as required.

5. COMMAND AND SIGNAL. Instructions relative to command and operation of signal communications, construction, and photography, including reference to an annex. Includes the index and issue number of signal operations instructions (SOI) in effect, command post locations, designation of alternate command posts and axis of CP displacement.

ACKNOWLEDGEMENT INSTRUCTIONS

Commander (name and grade)

Annexes

Distribution

Authentication

6-2. Logistics Annex to Operation Plan or Order

COPY No. _____

Issuing headquarters

Place of issue (may be in code)

Date-time group of signature

Message reference number

Annex _____ (logistics) to Operation Plan _____

References: Maps, charts, and other relevant documents.

1. GENERAL SITUATION. Information on the overall situation essential to understanding the logistical plan.

a. Enemy forces. Composition, disposition, location, movement, estimated strength, identification, and capability.

b. Friendly forces. Commanders' responsibilities affecting the logistical plan.

c. Attachments and detachments. Units attached to or detached from the issuing unit and effective times.

d. Assumptions. Assumptions on which the plan is based (normally applicable only to higher planning echelons).

2. MISSION. A clear, concise statement of the task to be accomplished by the command and the purpose of the task.

3. TASK FOR SUBORDINATE UNITS. Separate, lettered subparagraphs giving the specific task or responsibility of each subordinate command.

4. MATERIEL AND SERVICES.

a. Supply.

(1) Installations. Instructions to installation commanders on missions, issue and collection of supplies and material, locations and times of opening or closing of installations, operating units, supported units, stocks and levels, credits, and type of storage.

(2) Requirements. General statement on tonnage requirements, levels of supply to be achieved during different periods, and special information on certain items, such as water supply in the area where water is scarce.

(3) Requisition and procurement. Information on normal requisitioning and on local procurement.

(4) Distribution. Instructions on receipts, shipments, and issues.

(5) Civilian supplies. Instructions on issuing supplies to civilians.

(6) Salvage. Instructions on collection, classification, and disposition of salvage.

(7) Captured supplies. Instructions on reports, collection, segregation, and disposition of captured materials.

(8) Responsibilities.

b. Transportation.

(1) General. General information on policies.

(2) Motor. Traffic regulation and control.

(3) Rail. Locations, facilities, capacities, and restrictions.

(4) Water. Ports and beaches in use and to be placed in use, facilities, capacities, and restrictions. (Separate subparagraphs for ocean, coastal, and inland waterways.)

(5) Pipelines. Locations, sizes, capacities, and restrictions.

(6) Air. Airfield capacities and restrictions.

(7) Transportation movements. Instructions for management of the movement capability.

(8) Responsibilities.

c. Support.

(1) Organization. Support groups, trains, and depots; bivouacs and movement of unit trains; assignment or attachment of support units to subordinate units or commands.

(2) Support. Support installations, locations, operating units, and assignments to supported units; special missions, priorities, schedules, and limitations not covered in other orders. (May be divided more simply by types, such as maintenance, construction, utilities, and real estate.)

(a) Chemical. Decontamination and impregnation.

(b) Engineer. Construction, firefighting, maintenance, procurement, real estate, reproduction, and utilities.

(c) Medical. Medical, dental, and veterinary; laboratory, spectacle; special hospitalization, preventive medicine, health, and sanitation.

(d) Ordnance. Inspection, maintenance, procurement, waterproofing, and bomb disposal.

(e) Quartermaster. Bathing and fumigation, labor, laundry maintenance, personal effects service, procurement sales, remount service, and responsibility for salvage and petroleum supply and testing.

(3) Labor. Policies pertaining to the use of civilian (U.S. and non-U.S.) and prisoner-of-war personnel.

(4) Responsibilities.

5. MEDICAL: EVACUATION AND HOSPITALIZATION.

a. Evacuation. Dispensaries and clearing stations, locations, times of opening or closing, operating units, and units supported; policies, estimated rates, and channels for evacuation of injured, sick, and wounded, including prisoners of war and civilians.

b. Hospitalization. General instructions for all personnel, including prisoners of war and civilians, policies, locations, and capacities of hospitals.

c. Responsibilities.

6. MISCELLANEOUS.

a. Boundaries. Locations—present and proposed.

b. Headquarters. Locations of headquarters and instructions for movement.

c. Security. Instructions for protection and defense of installations and facilities.

d. Area damage control. Measures to reduce damage potential in logistical installations, including instructions pertaining to traffic control (may be issued as an overlay), evacuation, and hospitalization.

e. Reports. Types required, time due, and subject matter covered.

f. Conservation of supplies. General instructions for safeguarding, use, maintenance, and conservation of supplies.

- g. Effective date of plan.
- h. Responsibilities.

ACKNOWLEDGMENT INSTRUCTIONS.

Commander (name and grade)

Appendixes

Distribution

Authentication

6-3. Administrative Order

(Subparagraphs which do not apply are omitted.)

COPY No. _____

Issuing headquarters

Place of issue (may be in code)

Date-time group of signature

Message reference number

Administrative order: Type and serial number. (Type is usually indicated in combined or joint operations but omitted within a single service. When required, a code title may also be included.)

References: Maps, charts, and other relevant documents.

Time zone: Used throughout the order; if unnecessary, omit.

1. GENERAL. Outline of the administrative plan; any orders that are not suitably covered by succeeding paragraphs; e.g., location of administrative area in a divisional order (may be issued as an annex or overlay); and traffic circulation plan (may be issued as an annex or overlay.)

2. MATERIEL AND SERVICES. Supplies (normal daily requirements), either by types of supply or by branches of service, transport, transportation services, repair and recovery (maintenance), construction, other services, allocation of labor, etc., in the order suitable to the staff procedures of the army concerned.

a. Supply. Installations concerned with the issue and collection of supplies and material; locations and, where applicable, time of opening or closing; operating units; supported units; stocks and levels; and credits. Instructions on submission of nonroutine reports or temporary changes regarding the submission of routine reports concerning the particular supplies listed; removal, collection, and disposition of, and reports concerning excess, salvage, and captured supplies; overall levels of supply; and methods or schedules of supply distribution. Organized in one of or a combination of the following methods:

<u>Class of supply</u>	<u>Commodity of supply</u>	<u>Type of installations</u>
(1) Class I	(1) Chemical	(1) Field depot
(2) Class II	(2) Engineer	(2) Special depot
(3) Class III	(3) Medical	(3) Supply point
(4) Class IV	(4) Ordnance	(4) Railhead
(5) Class V	(5) Quartermaster	(5) Truckhead
(6) Maps	(6) Signal	(6) Miscellaneous
(7) Water	(7) Transportation	
(8) Special	(8) Miscellaneous	
(9) Excess		
(10) Salvage		
(11) Captured materiel		

b. Transportation. Terminals and installations (rail stations, airfields, ports, and beaches), operating units, schedules (march tables, timetables, and entraining tables), control measures (traffic regulation and control, allocations, priorities, restrictions, route markings, and regulating points). (Items cover the entire transportation field and are not necessarily restricted to Transportation Corps operations.)

- (1) Ocean.
- (2) Inland waterway.
- (3) Coastal.
- (4) Motor.
- (5) Rail.
- (6) Pipeline.
- (7) Air.
- (8) Miscellaneous.

c. Support.

(1) Organization. Support groups, trains, and depots; bivouacs and movement of unit trains; assignment or attachment of service units to subordinate units or commands.

(2) Support services. Support installations, locations, operating units, and assignments to supported units, and special missions not covered in other orders.

- (a) Chemical.
- (b) Engineer.
- (c) Medical.
- (d) Maintenance.
- (e) Quartermaster.
- (f) Transportation.

d. Labor. Policies pertaining to the use of civilian (non-U.S. and U.S.) and prisoner-of-war personnel.

3. MEDICAL: EVACUATION AND HOSPITALIZATION.

a. Evacuation. Dispensaries, collecting stations, and clearing stations; locations, times of opening or closing; operating units; units supported; routes, means, schedules, and responsibilities for evacuation; evacuation and treatment policies.

b. Hospitalization. Hospitals (evacuation, station, general, field, convalescent); locations, times of opening or closing; and units supported.

4. PERSONNEL. Reporting procedures, replacement, discipline, law and order, prisoners of war, burials, morale, welfare, civilian employees, etc., in the order suitable to the staff procedures of the headquarters concerned. Under each subparagraph or specific personnel activity the following are listed when applicable: the operating installation, service, or depot; location and hour and date of opening or closing; the units operating the installation; attachment or assignment of operating personnel; the units or areas served; credits or quotas allocated to units; unit responsibility for movement or administration of personnel; reports required; requisitions or plans concerning personnel activities; references to previous orders, instructions, or standing operating procedure.

a. Strengths. Instructions for presenting personnel strengths.

b. Replacements. Requirements (present and anticipated), requisitioning allocating, processing and moving replacements, location and stockage of replacement units, and location of unit replacements.

c. Discipline, law, and order. Troop conduct and appearance, control, and disposition of stragglers, administration of military justice, and relations with civilians.

d. Prisoners of war. Collection, safeguarding, processing, evacuation, utilization, treatment, and discipline.

e. Recovery and disposition of remains. Cemeteries, evacuation, personal effects, and ceremonies.

f. Morale and personnel services.

(1) Morale. General instructions concerning morale.

(2) Personnel services. Leaves, rest and recreational facilities, decorations and awards, postal and finance services, religious activities, personal hygiene, special service activities, Army exchanges, welfare activities, and legal assistance.

g. Personnel procedures. Classification, assignment, promotion, transfer, reclassification, demotion, elimination, retirement, separation, training rotation, and personnel economies.

h. Headquarters management. Movement, internal arrangement, organizational, and operation; allocation of shelter for headquarters personnel.

i. Civilian personnel. Sources, procurement, utilization, administration, control, relation to military government, and relation to troops.

j. Miscellaneous. Personnel matters not specifically assigned to another general staff section.

5. CIVIL AFFAIRS. Allocation and deployment of civil affairs (CA) units, control of refugees, feeding and treatment of civil population, etc.

a. Civil affairs units. Locations of all CA units in area; procedures for requesting support of these units.

b. Government. Establishment of relationship between military and civil authorities; instructions for tactical units on seizure and protection of government offices, records, and personnel; issuance of proclamations, laws, ordinances, and notices.

(1) Law. Jurisdiction of legal framework; authorization for closing local, criminal and civil courts; authorization and procedures for military courts.

(2) Public order and safety. Measures for control of, or assistance to, local government to restore public order and safety; collection and disposition of arms, ammunition, explosives, etc.; civil defense and integration of civil defense and military warning systems; control of liquor and narcotics.

c. Economy. Protection and prevention of exploitation of natural resources and other economic necessities.

(1) Commerce and industry. Designation of "Off Limits" areas. Specific responsibilities for safeguarding essential commerce and industry.

(2) Food and agriculture. Procedures for safeguarding agricultural stocks and food supplies; restrictions on troop use.

(3) Price control and rationing. Prevention of black marketing; control of requisitioning and purchasing of civilian supplies.

(4) Property control and protection.

(5) Public finance. Requirements for securing banks and funds; restriction of currency.

(6) Civilian supply. Use of civilian and military supplies for aid to civilians; procedures for distribution.

(7) Labor. Procurement of labor; restrictions on employment of civilians.

(8) Public works and utilities. Reestablishment as required; authorized military use.

(9) Public transportation. Reestablishment as required; authorize military use.

(10) Public communications. Reestablishment, protection, restrictions, and censorship; authorized military use.

(11) Civil information. Control and military use.

d. Public welfare.

(1) Health. Prevention and treatment of disease.

(2) Relief and supply. Minimum requirements for food, clothing, and shelter; provision, if necessary.

(3) Education. Preservation of educational systems and facilities, control measures.

(4) Refugees and displaced persons. Control, care, and disposition; location of facilities; instructions for evacuation requests.

(5) Arts, monuments, and archives. Security and protection.

e. Miscellaneous. Special instructions pertaining to civil affairs not covered above.

6. MISCELLANEOUS. Any special instructions not covered above.

- a. Boundaries.
- b. Headquarters.
- c. Security.
- d. Area damage control.
- e. Reports.
- f. Other administrative and logistical matters.

ACKNOWLEDGEMENT INSTRUCTIONS.

Commander (name and grade)

Annexes

Distribution

Authentication

6-4. Transportation Annex to Administrative Order (Sample)

COPY No. _____

10th U.S. Army

Location: (coordinates)

Time and date: _____

Annex _____ (Transportation) to ADMINO No. _____

References: Maps, charts, and other relevant documents.

1. SITUATION

- a. Intelligence report No. _____, Hq 10th U.S. Army, Dated _____.
- b. Operations report No. _____, Hq 10th U.S. Army, dated _____.
- c. TALOG furnishes necessary rail and water terminal transportation service in support of 10th U.S. Army.
- d. 5th U.S. Air Force furnishes necessary air transportation service in support of 10th U.S. Army.

2. MISSION. Transportation elements will provide transportation service support for assigned and attached troops of 10th U.S. Army and transportation service support for Air Force units to base level.

3. EXECUTION.

- a. 48th Trans Gp (Trk), _____, furnishes highway transportation service as directed.
(coordinates)

- (1) 264th Trans Bn (Trk), _____
(coordinates)
- (2) 265th Trans Bn (Trk), _____
(coordinates)
- (3) 266th Trans Bn (Trk), _____
(coordinates)
- (4) 267th Trans Bn (Trk), _____
(coordinates)

b. 54th Trans Gp (Trk), _____, furnishes highway transportation service as directed.
(coordinates)

- (1) 465th Trans Bn (Trk), _____
(coordinates)
- (2) 467th Trans Bn (Trk), _____
(coordinates)
- (3) 468th Trans Bn (Trk), _____
(coordinates)
- (4) 469th Trans Bn (Trk), _____
(coordinates)
- (5) 488th Trans Bn (Trk), _____
(coordinates)

c. 429th Support Gp, _____, furnishes field maintenance and supply support for Army fixed-wing and rotary-wing aircraft as required.
(coordinates)

- (1) 233d Trans Bn (TAAM & Sup, DS), _____
(coordinates)
- (2) 234th Trans Bn (TAAM & Sup, DS), _____
(coordinates)
- (3) 235th Trans Bn (TAAM & Sup, DS), _____
(coordinates)
- (4) 322d Trans Bn (TAAM & Sup, GS), _____; operates
(coordinates)
depot 631, C1 III-A items only, 5-day level; operates depot 632, C1 IV-A items only, 10-day level; supports all Army aircraft maintenance units.

d. 112th Aviation Bn _____
(coordinates)

- (1) Annex G (Army Aviation) to OPORD NO. 3, Hq 10th U.S. Army, dated _____.
- (2) Furnishes administrative support to Hq, 10th U.S. Army.

e. 113th Aviation Bn, _____:
(coordinates)
Annex G (Army Aviation) to OPORD No. 8, Hq 10th U.S. Army.

f. 433d Trans Bn (Trk), _____, attached to 1st Corps effective _____
(coordinates)

g. 263d Trans Bn (Trk), _____, attached to 2d Corps effective _____
(coordinates)

h. 463d Trans Bn (Trk), _____, attached to 3d Corps effective _____
(coordinates)

i. 257th Transportation Center (Movement Control), _____, manages transportation movements within army area; operates TMOs and maintains liaison with appropriate technical services.
(coordinates)

j. Alternate command posts and dispersal areas will be selected and maintained. All transportation units will be prepared to relocate on order.

k. Units will be prepared to perform secondary mission as infantry.

4. ADMINISTRATION AND LOGISTICS.

a. Supply.

(1) Supply levels.

(a) Primary depot—10 days.

(b) Secondary depot—5 days.

(2) Regulated items.

(a) Aircraft.

(b) All engines and power trains.

(3) Resupply.

Requisition schedule—10th and 25th day each month; equipment out of commission for parts—requisition as necessary.

b. Service.

(1) Transportation: Annex G, 10th U.S. Army SOP.

(2) Loading and unloading: Responsibility of consignors and consignees.

5. COMMAND AND SIGNAL.

a. Reports: Annex F, 10th U.S. Army SOP.

b. Army ACofs G-4: _____, phone _____
(coordinates)

c. Communications: Annex G, 10th U.S. Army SOP.

ACKNOWLEDGEMENT INSTRUCTIONS

Commander (name and grade)

Appendixes

Distribution

OFFICIAL

/s/

/t/ _____
ACofS, G-4

6-5. Outline for Transportation Standing Operating Procedure for Major Commands

STANDING OPERATING PROCEDURES

(command)

1. PURPOSE. Outline of purpose.
2. SCOPE. Application and coverage.
3. UNIT PROCEDURES. Action required by subordinate units in preparation of unit SOP, including a definite statement that SOP procedures of subordinate units will be based on and conform to the SOP procedures of the issuing command.
4. RESCISSIONS. Any publications superseded or rescinded by the SOP, including fragmentary SOPs, orders, memorandums, bulletins, or other directives.
5. REFERENCES. Publications to be used in conjunction with the SOP.
6. DEFINITIONS. Terms or phrases used in the SOP defined, as required, to insure understanding and correct interpretation.
7. TRANSPORTATION ORGANIZATION. Missions, organizations, and functions (unless published elsewhere) of the following:
 - a. Office of the transportation officer.
 - (1) Transportation officer.
 - (2) Deputy transportation officer or executive officer.
 - (3) Staff sections.
 - (4) Liaison officers: United States Air Force, Military Sea Transportation Service, Army, allied, and others.
 - b. Field installations.
 - (1) Water terminals.
 - (2) Transportation supply depots.
 - (3) Transfer points and other special transportation activities.
 - (4) Transportation movements branch and other transportation organization.
8. ADMINISTRATION.
 - a. General. Application and implementation of command policies and directives.
 - b. Correspondence.
 - (1) Types. Types; instructions for preparing, forwarding, and handling; paper economy measures.
 - (2) Classified documents. Types of classification and authority to classify; handling, delivery, and receipting methods and procedures; security measures and responsibilities.

c. Personnel.

(1) General. Application and implementation of command policies and directives.

(2) Local civilian labor. Implementation of command policies and administrative procedures for procurement, utilization, and pay; application of provisions of Geneva Convention.

(3) Prisoners of war. Implementation of command policies and administrative procedures for procurement as labor; utilization, treatment, and security; application of provisions of Geneva Convention.

(4) Replacements. Responsibilities and procedures for requisitioning transportation replacements; implementation or elaboration of command policies and directives.

d. Reports. Types and number of administrative reports to be submitted; method and frequency of submissions (samples to be appended); application of reports control procedures.

9. INTELLIGENCE

a. General. Purpose and importance of transportation intelligence, transportation intelligence mission, types of intelligence, application of command directives (FM 55-8).

b. Collection of information. Collection agencies, essential elements of information, sources, coordination, collection plan, methods, reporting and disposition of captured enemy material for intelligence purposes.

c. Processing information. Responsibilities and procedures for recording, evaluating, and interpreting information.

d. Dissemination. Policies, methods, criteria, security classifications, transmissions, time considerations.

e. Usage. General application of intelligence to transportation operations and planning; precautions against enemy counterintelligence.

f. Counterintelligence. Objectives, responsibilities, and application to the transportation service.

g. Reconnaissance. Purpose and responsibilities.

10. PLANS

a. Transportation requirements. Responsibilities for maintaining current lists of transportation requirements for movement of the unit or its elements by rail, truck, inland waterway, and air.

b. Transport availability. Responsibilities for maintaining current lists of available transportation—organic, assigned, or attached to the unit, including local civilian transportation.

c. Entrucking plans. Responsibilities of subordinate units for maintaining current entrucking plans; designation of vehicles to transport personnel, supplies, and organizational equipment.

d. Traffic circulation plans. Statement that traffic circulation plans will be coordinated with traffic circulation plan of this headquarters.

e. Special operations. Statement that transportation aspects of subordinate troop plans for special operation (e.g., river crossing, pursuit, retrograde movement) will be coordinated with this headquarters.

f. Plans by units in reserve. Statement that plans by these units for forward or lateral movement will be coordinated with this headquarters.

g. Pooling organizational transportation. Procedures, including availability reports, unit responsibilities for furnishing commissioned and non-commissioned officers, maintenance of equipment, and administrative support of personnel.

h. Civil aid. Statement that services and subordinate units will submit plans in advance for movement of civilians and civil aid supplies, but that plans will not be implemented without prior approval.

i. Main supply routes and supply and service installations. Responsibilities and procedures for maintaining up-to-date plans for recommending main supply routes and service installations.

11. TRAINING

a. Responsibilities and procedures for preparing and supervising training programs of transportation units.

b. Responsibilities and procedures for exercising technical supervision over transportation training throughout the command.

12. DEFENSE AND DISPERSION. Implementation of command policies and directives; responsibilities of corps transportation units for area of defense; defense against airborne, bacteriological, nuclear, and chemical attack; sabotage; and infiltration and guerrilla warfare; procedures for reporting enemy activity.

13. AMPHIBIOUS OPERATIONS

a. General. This SOP standardizes normal procedures in the preparation and execution of amphibious operations and will apply unless otherwise prescribed.

- (1) Subordinate units issue SOP to conform.
- (2) References.

b. Planning. Consideration must be given to the following:

- (1) Requirements of the tactical plan and the scheme of maneuver.
- (2) Availability of landing craft and ships by type, size, cargo, personnel capacity.
- (3) Establishing and maintaining close liaison with the Navy, the Air Force, and task-force commanders.
- (4) Landing force embarkation and tonnage and the breakdown of equipment and supplies as indicated in tables to be submitted by task-force commanders.
- (5) Arranging and coordinating through channels for training appropriate personnel in unit loading and embarkation.

(6) Movement of the embarkation areas and delivery of equipment and supplies, including waterproofing, marking, and palletizing.

(7) Supervision within the embarkation area.

(8) Buildup period for supplies and ship turnaround time.

(9) Alternate logistical procedures or an entire alternate plan to support alternate tactical plans being considered.

c. Movement to the staging area.

(1) Warning orders.

(2) Method of movement—rail, highway, air, water.

(3) Control of movement.

d. Staging area.

(1) Reception.

(2) Spot delivery of equipment.

(3) Control points to control flow of equipment and personnel to embarkation points or assembly areas.

Assembly areas for temporary storage of equipment and supplies to be loaded on transports.

(5) Transportation to haul supplies and equipment from assembly areas to ships.

(6) Areas where final waterproofing can be completed.

(7) Facilities to prepare cargo not already processed for loading.

e. Embarkation of troops.

(1) Movement to embarkation point or assembly areas.

(2) Control of movement to vessels.

f. Movement to objective area. In accordance with naval directives.

g. Ship-to-shore movement.

(1) Debarkation of equipment, supplies, and service troops at the proper time to support tactical operation.

(2) Control and landing of emergency supplies.

(3) Evacuation of casualties by water.

h. Beach organization.

(1) Transportation unit reconnaissance party.

(2) Consolidation of supplies and transportation for subsequent logistical support of the landing force.

3. Control.

(a) Vehicular traffic.

(b) Transfer operations (buildup area).

(4) Communication between beach organization and control vessel and ships.

14. INSPECTIONS

a. Reference: SOP of higher headquarters relative to inspections.

b. Purpose.

c. Policy.

d. Types of inspections: vehicle utilization, transportation training, quality of maintenance and maintenance support, efficiency of operations, records system.

e. Frequency.

f. Procedures before making an inspection.

g. Procedures upon completing an inspection.

h. Reports on findings, including a sample format, number of copies, and distribution.

15. AIRBORNE OPERATIONS. Implementation of command policies and directives in establishing responsibilities and procedures for transportation unit participation in airborne operations.

16. COMMUNICATIONS

a. Communications for coordination of transportation.

b. Air-ground communications for coordination of airdrops and land transportation.

c. Reference to communications diagram.

Commander (name and grade)

Annexes

Distribution

Authentication

6-6. Outline for Transportation Standing Operating Procedure for Units

STANDING OPERATING PROCEDURES

Unit

TABLE OF CONTENTS

Section I. GENERAL

1. APPLICATION. (Operations to which SOP applies.
2. PURPOSE
3. REFERENCES. (FMs, TMs, SOPs of higher headquarters, etc.)
4. RESPONSIBILITY FOR PREPARATION, CHANGES, REVISIONS
5. EFFECTIVE DATE

Section II. COMMAND, STAFF, LIAISON

6. ORGANIZATION

- a. Normal.
- b. Special internal attachments and organization.
- c. Normal and special external attachments and support.

7. COMMAND POSTS

- a. Normal location in relation to next higher headquarters.
- b. Reporting change of location—coordinates and time.
- c. Forward command posts.
 - (1) Situation for which required.
 - (2) How organized.
 - (3) Personnel and equipment.

8. STAFF DUTIES

- a. Special or additional duties of staff officers.
- b. Duties of special staff officers.

9. LIAISON

- a. Duties of liaison officers.
- b. Responsibilities for liaison—higher, lower, and adjacent units.

10. PLANNING RESPONSIBILITY

Section III. ADMINISTRATION

11. GENERAL CHANNELS

12. REPORTS

- a. Routine reports.
- b. Special reports.
- c. Submission.
 - (1) Title and reports-control symbol.
 - (2) Firm of report.
 - (3) Date due.
 - (4) Number of copies.
 - (5) Negative report required or permissible.

13. PROMOTION POLICIES

- a. Officer.
- b. Enlisted.
- c. Battlefield.

14. COURTS-MARTIAL
 - a. Location jurisdiction.
 - b. Procedure for submitting cases.
15. MAIL
 - a. Handling of official mail.
 - b. Handling of personal mail.
16. LEAVES AND PASSES
 - a. Policy of command—conduct, VD control.
 - b. Authority to grant.
17. JOURNALS AND HISTORY
 - a. Responsibility for unit journal and history.
 - b. Maintenance of staff section journals.
18. DISTRIBUTION OF MILITARY PUBLICATIONS
19. HANDLING OF PRISONERS OF WAR
 - a. Reference to FM 19-40 and FM 27-10.
 - b. Special instructions for capturing unit.
20. AWARDS AND DECORATIONS
 - a. Channels.
 - b. Form.
 - c. Presentation.
21. ORDERS) FM 101-5)
22. BILLETS AND BIVOUACS
 - a. Policies—occupation and clearance.
 - b. Billeting party.

Section IV. MOVEMENT

23. GENERAL (SOP of higher headquarters)
24. MOTOR MOVEMENT (FM 55-9 and FM 55-35)
 - a. Preparation of vehicles.
 - b. Motor marches.
 - (1) Strip maps.
 - (2) Route reconnaissance.

- (3) Messing and refueling.
- (4) Night marches.
- (5) Makeup of march units and serials.
- (6) Distances to be maintained.
- (7) Speed and rate of march.
 - (a) Rate of march for column.
 - (b) Speed of lead vehicle.
 - (c) Permissible speed to catch up.
 - (d) Time length of march unit or serial.
- (8) Posting of traffic guards during halt.

c. Movement by infiltration.

d. Conduct of personnel during movement.

- (1) Passengers.
- (2) Drivers.

25. VEHICLE AND EQUIPMENT OPERATIONS

a. Motor pool.

- (1) Dispatch.
- (2) Service.
- (3) Maintenance.

b. Regulations for administrative vehicles.

26. RAIL MOVEMENTS

a. Action by S1—Movement policy.

b. Action by S2.

- (1) Reconnaissance report.
- (2) Security.

c. Action by S3.

- (1) Troop list.
- (2) Coordination of loading plan.
- (3) Transportation movement teams.

d. Action by S4.

- (1) Initiation of transportation request.
- (2) Provision for troop and guard mess.
- (3) Procurement of blocking and dunnage.
- (4) Preparation of shipping documents.
- (5) Determination of rolling stock required.
- (6) Preparation of loading schedules and area.

21. AIR MOVEMENT

a. Action by S1.

b. Action by S2.

- c. Action by S3.
 - (1) Determination of craft required.
 - (2) Coordination of loading plan.
 - (3) Preparation of loading schedule and areas.
 - (4) Explanation of air-transportability technique.
- d. Action by S4.
 - (1) Initiation of transportation request.
 - (2) Determination of availability of tiedown devices or material.
 - (3) Preparation of weight-of-equipment data for loading computation.
 - (4) Preparation of shipping documents.
 - (5) Determination of quantity and types of vehicles required to load and unload aircraft.

28. WATER MOVEMENT

- a. Action by S1—Movement policy.
- b. Action by S2.
 - (1) Reconnaissance report.
 - (2) Security.
- c. Action by S3.
 - (1) Troop list.
 - (2) Coordination of loading plan.
 - (3) Transportation movement teams.
- d. Action by S4.
 - (1) Initiation of transportation request.
 - (2) Provision of troop mess.
 - (3) Preparation of shipping documents.
 - (4) Determination of shipping required.
 - (5) Preparation of loading schedule and area.

Section V. SECURITY

29. GENERAL: POLICIES AND RESPONSIBILITIES

30. SECURITY DURING MOVEMENT

- a. Air guards.
- b. Manning of vehicular weapons.
- c. Camouflage during halts.
- d. Advance, flank, and rear guards.
- e. Action to be taken in case of attack.
 - (1) Air.
 - (2) Mechanized.

- (3) Troops and guerrillas.
- (4) Nuclear, biological, chemical.

31. SECURITY IN BIVOUAC

- a. Camouflage.
- b. Mines and boobytraps.
- c. Placement of weapons in case of attack.
 - (1) Air.
 - (2) Mechanized.
 - (3) Troops and guerrillas.
 - (4) Nuclear, bacteriological, chemical.
- d. Joint security.
- e. Security plans.
- f. Sentry posts and outposts.

32. ATTACK WARNING SIGNALS

- a. Air.
- b. Airborne.
- c. Mechanized.
- d. Troops and guerrillas.
- e. Nuclear, biological, chemical.

33. FIRE SAFETY AND FIRE FIGHTING

- a. Plans.
- b. Fire personnel and duties.
- c. Safety rules (motor pool, kitchen, etc.).

34. ALERT PLANS

- a. Unit plan.
- b. Alert roster.
- c. Armament and equipment.
- d. Phase system for alert warnings.

35. DESTRUCTION OF EQUIPMENT

Section VI. COMMUNICATIONS

36. AVAILABLE MEANS

37. ESTABLISHMENT OF COMMUNICATIONS

- a. Organic communications.

- b. Area communications support.
- c. Responsibilities.

38. COMMUNICATION PROCEDURES

- a. Voice radio.
- b. Radio/wire integration (RWI).
- c. Message.
- d. Visual and sonic.
- e. Reference to SOI and SSI of higher headquarters.

39. SIGNAL MAINTENANCE RESPONSIBILITIES

- a. Commander.
- b. Signal/Communications Officer.
- c. Operators.
- d. Users.

Section VII. RECONNAISSANCE, INTELLIGENCE,
AND COUNTERINTELLIGENCE

40. RECONNAISSANCE. Essential elements of information.

41. COMBAT INTELLIGENCE

- a. Definition of "spot reports."
- b. "Spot reports" required:
 - (1) Initial contact with enemy.
 - (2) Marked change in enemy disposition or situation.
 - (3) Attack by armored, air, or airborne forces.
 - (4) New units identified.
 - (5) Enemy strength, composition, and movement.
 - (6) Location of enemy installations.
 - (7) Use of chemicals or new weapons.
 - (8) New materials or equipment.

42. COUNTERINTELLIGENCE

- a. Mail censorship.
- b. Blackout discipline.
- c. Information to be given if captured.
- d. Signs and countersigns.
- e. Destruction of classified documents.
- f. Civilian control.
- g. Secrecy discipline.
- h. Information to press representatives.

Section VIII. SUPPLY AND MAINTENANCE

- 43. CLASS I SUPPLY
 - a. Ration pickup.
 - b. Daily ration return and ration cycle.
 - c. Reserve rations carried.
 - (1) By unit.
 - (2) By individual.
 - d. Responsibility for attached units.
- 44. WATER
 - a. Authorized source.
 - b. Purification by expedient methods.
 - c. Water economy.
- 45. CLASS II AND IV SUPPLY
 - a. Requisition days for various services.
 - b. Pickup procedure.
 - c. Salvage turn-in procedures.
 - d. Droppage by battle-loss certificate.
- 46. CLASS III SUPPLY
 - a. Resupply.
 - b. Fuel reserve.
- 47. CLASS IIIA SUPPLY
 - a. Resupply.
 - b. Fuel reserve.
- 48. CLASS V SUPPLY
 - a. Method of requisitioning.
 - b. Forms used and certificates required.
 - c. Basic load.
 - d. Salvage.
- 49. MAINTENANCE OF VEHICLES AND EQUIPMENT
 - a. Category of maintenance.
 - b. Responsibility of maintenance officer.
 - c. Forms used.
 - d. Priorities.

50. REPAIR PARTS

- a. Method of requisitioning.
- b. Maintenance of stock levels.
- c. Inspections of maintenance and levels.
- d. Parts and equipment record.

51. EVACUATION CHANNELS FOR VEHICLES AND EQUIPMENT

By order of _____

Adjutant (name and grade)

Annexes. (May include Wearing of the Uniform, Reports Formats, Destruction of Classified Documents, Duties of Staff Officers, Staff Section SOPs, Loading Plans, Alert Plan, etc.)

Distribution

Authentication

6-7. Division Embarkation Order

Issuing unit

Place of issue (may be in code)

Hour and date of issue

File No. _____

Embarkation Plan No. _____

Maps: (Those needed for understanding the plan.).

References: (SOPs, operation order, administrative order, and other relevant material.).

1. ORGANIZATION FOR EMBARKATION

a. Troop list for each embarkation group. (May be issued in form of annex.)

b. Assignment of each embarkation group to shipping, schedule showing berthing of ships, date and hour loading will begin, and date and hour embarkation will be completed by each embarkation group; other information pertinent to the embarkation group; other information pertinent to the embarkation schedule may be included. (May be issued in form of annex.)

c. Advance parties.

(1) Composition.

(2) Functions.

(3) Movement to embarkation point. (Reference to SOP if applicable.)

2. SUPPLIES AND EQUIPMENT TO BE EMBARKED

- a. Amounts and types of supplies and equipment to be embarked.
- b. Preparation of supplies and equipment for embarkation. Reference may be made to appropriate SOP.
- c. Allocation of division supplies and equipment to cargo assembly areas. (May be issued in form of annex with appendixes.)

3. EMBARKATION POINTS AND CARGO ASSEMBLY AREAS

- a. Assignment of embarkation points and cargo assembly areas for loading. (May be in the form of a map, sketch, or overlay, and issued as an annex.)
- b. Preparation of embarkation points and cargo assembly areas for loading; construction or improvement of exits and facilities in the embarkation area.
- c. Assignment of mechanical loading devices, such as forklift trucks, cranes, roller conveyors, warehouse pallets, etc.

4. CONTROL

- a. Establishment and functions of embarkation control office. (Functions may be covered in SOP.)
- b. Traffic circulation and control system in embarkation area and between embarkation area and base camp.
- c. Establishment of security posts for prevention of fire, sabotage, and pilferage in cargo assembly and deck areas.
- d. Communications for embarkation. (References may be made to SOI.)

5. MOVEMENT AND EMBARKATION OF PERSONNEL

- a. Schedule and method of movement from base camp.
- b. Schedule and instruction for embarkation.

6. MISCELLANEOUS

- a. Embarkation responsibilities and tasks. Responsibility of embarkation group commanders and tasks of officers, such as supply officer, motor transport officer, unit loading officer, etc.
- b. Special loading instructions. Stowage of certain types of cargo, handling of fragile or dangerous items, etc.
- c. Miscellaneous instructions not covered elsewhere.

ACKNOWLEDGEMENT INSTRUCTIONS

By Command of Major General _____

s/Colonel, U.S. Chief of Staff

Annexes:

ALPHA—Organization of Embarkation Groups—Assignment of Shipping.

BRAVO—Loading Schedule.

CHARLIE—Supplies and Equipment to be Embarked.

DELTA—Embarkation Points and Cargo Assembly Areas. (Others as necessary.)

DISTRIBUTION:

OFFICIAL _____
s/Lt Col, U.S., ACofS, G4

Section II. INTELLIGENCE

6-8. Transportation Intelligence

Transportation intelligence is the product resulting from the collection, evaluation, interpretation, analysis, and integration of all available information about air, land, and water transportation systems which are of immediate or potential military significance. Intelligence includes data on the characteristics, condition, development, organization, materiel, operation, maintenance, and construction of transportation systems and facilities. These data are essential to strategic, logistical, and tactical planning. Formats for recording and reporting transportation information and intelligence are shown in FM 30-16.

6-9. Transportation Intelligence Estimate

a. General. Transportation intelligence estimates are studies that describe, discuss, and apply interpreted data that, directly or indirectly, concern the transportation mission. These estimates are used by commanders in making sound and timely decisions and are part of the overall transportation estimate used to formulate the transportation plan. Since intelligence estimates are made after all available information has been collected and processed, they must be kept current by revision when new or additional information is received and processed. Estimates must be disseminated to appropriate planners in sufficient time to be useful. If there is not enough time for making and publishing of formal trans-

portation plans, intelligence estimated may be disseminated directly to the ultimate users—the operating units.

b. Elements Considered. An estimate does not necessarily contain all of the elements listed below; content depends upon the transportation mission.

(1) Statement of the transportation mission.

(2) Characteristics of the area of operations and how they will affect this mission.

(a) Weather and climate: temperatures, wind conditions, rainfall, tide and river conditions, and a complete aeronautical weather forecast.

(b) Terrain features: critical terrain features, any obstacles known or suspected, soil trafficability, offshore gradient of beaches, surf, etc.

(c) Road and rail nets, including traffic bottlenecks: available lines of communication, capacity, condition, damage, repair work necessary.

(d) Bridges and tunnels: possible bottlenecks, such as bridges, tunnels, ruling grades, etc.

(e) Port and beach facilities and wharves.

(f) Airfields and other aircraft facilities.

(g) Inland waterways, locks, ports.

(h) Warehouses and other storage facilities.

(3) Characteristics of enemy transportation equipment.

(a) Locomotive characteristics and inventory.

(b) Freight and passenger equipment characteristics and inventory.

(c) Vehicle characteristics and inventory.

(d) Crane data.

(e) Waterway craft (inland waterway and oceangoing) characteristics and inventory.

(f) Aircraft characteristics and inventory.

(4) Transport capability of the enemy: air, water, motor, rail, miscellaneous. Include the enemy's capabilities to attack, defend, delay, withdraw, and reinforce, and probable areas involved, strengths, etc. Indicate how the transportation mission could be affected by each capability of the enemy, including such items as lines of communication apt to be lost or gained through enemy's use of each capability and increase or decrease in tonnage capability. (This could be done in an annex which lists probable effect of each capability on each mode.)

(5) Conclusions, including effect of the intelligence estimate on U.S. and friendly forces.

Section III. TRANSPORTATION ESTIMATE AND PLAN

6-10. Transportation Estimate

TRANSPORTATION ESTIMATE

Transportation Section (Unit)

(Location)

(Date-time group)

Maps: (Sheet name, number, scale, and unit of measure series.)

1. **MISSION.** Mission of the command and of the transportation units in support of the tactical and logistical mission of the command. (May be obtained from orders from a higher headquarters or deduced from instructions or knowledge of the situation and may be expressed in terms of personnel and/or tons of cargo to be transported, discharged, and/or outloaded.)

2. THE SITUATION AND CONSIDERATIONS

a. Intelligence situation. Refer to pertinent intelligence estimate.

b. Tactical situation.

(1) Refer to current operation order.

(2) Present and planned disposition of major friendly tactical elements, with emphasis on those units defending lines of communication or transportation units and operations; effect of planned troop moves on transportation operations.

(3) All possible courses of action open to the command to accomplish the assigned mission.

(4) Concept of projected operations once the immediate mission is accomplished.

c. Logistical situation.

(1) Refer to current administrative order or overlay.

(2) Status of supplies and equipment in all transportation organizations of the command, highlighting any inadequacies.

(3) Any projected developments likely to affect the ability of transportation units to perform their mission from the logistical standpoint.

(4) Status of supplies and equipment in other support units to be employed in logistical support of transportation operations which might adversely affect accomplishment of the mission.

(5) All possible logistical courses of action, and the affects of each on possible friendly tactical courses of action.

d. Personnel situation.

(1) Refer to current administrative order or overlay.

(2) Status of personnel in all transportation units, including state of morale and any other considerations likely to have a bearing on their performance.

(3) Status of personnel in other support units to be employed in logistical support of transportation operations which might adversely affect accomplishment of mission.

e. Assumptions. Logical assumptions may be made when a sufficient amount of factual information is not available for the preparation of the estimate.

f. Transportation situation. All known information, as detailed as possible, on each mode of transportation activity.

(1) Transportation situation by modes. The format shown in (a) below should be modified as required for (b) through (j).

(a) Rail. Tabulate as shown.

Unit	Location	Strength	Facilities	Equipment Lacking	Capability
		Actual— Auth	Actual— Required		Actual— Potential
	(b) Motor.				
	(c) Inland waterway.				
	(d) Air.				
	(e) Water.				
	(f) Transportation movements.				
	(g) Staging areas.				
	(h) Transportation depots.				
	(i) Pipelines (even though not operated by transportation units).				
	(j) Troop carrier space.				

(2) Transportation units courses of action. All courses of action open to transportation units for each possible logistical course of action set forth in c(5) above.

g. Special factors. Any other factors which might influence the choice of a course of action or the ability to perform mission, both from the transportation standpoint and from the overall view of the mission.

3. ANALYSIS. Statement and analysis of the effects of each logistical course of action listed in paragraph 2c(5) above on each mode of transportation.

a. Course of action.

Mode of activity*	Effect on personnel	Effect on equipment	Effect on facilities	Effect on capabilities
-------------------	---------------------	---------------------	----------------------	------------------------

*Same modes of activity as 2f(1) above.

b. Alternate course of action. Outline of alternate course(s) of action, if possible.

4. COMPARISON

a. Dominant transportation factors and modes most likely to be used.

b. A comparison, based on the information in paragraph 3, of the various logistical courses of action, including their effects on each mode and their capabilities thereof. (Through this weighing of advantages and disadvantages, the most favorable course of action from the transportation standpoint can be determined.)

c. Feasibility of the use of the various lines of communication, ports, and beaches in comparison with enemy capabilities, weather, terrain, etc.

5. CONCLUSIONS

a. Statement indicating whether the mission (para 1 above) can be accomplished from the standpoint of transportation support.

b. Statement indicating which of the possible logistical courses of action can best be supported from the transportation standpoint.

c. Statement calling attention to any considerations required should alternate courses of action be chosen.

(1) Number and type of transportation units required over and above those available for each course of action if mission cannot be supported.

(2) Personnel and/or equipment shortages in existing units which would prevent accomplishment of mission.

(3) Any repairs or construction work essential to successful accomplishment of the mission from the transportation standpoint.

(4) Any other transportation considerations which should be brought to the attention of the commander.

/s/

Transportation officer
(name and grade)

Annexes

Distribution

6-11. Transportation Plan

(Any of the paragraphs and subparagraphs below may consist wholly, or in part, of references to the appropriate annexes, and the annexes in turn may be amplified by properly referenced appendixes. Each transportation mode should have a separate annex.)

TRANSPORTATION PLAN _____

(Number)

Transportation Section (Unit)

(Location)

(Date-time group)

Maps and references: Sheet name, number, scale, and unit of measure, series shown for each map. Other references include city plans, navigation charts, other plans bearing on the transportation plan, etc.

Task organization: Annex A, Task Organization.

1. SITUATION

a. Enemy forces. All capabilities of the enemy to hinder, disrupt, or otherwise affect the operations of the transportation units and other elements of the command, including such items as damage to lines of communications, use of mass destruction weapons, etc. (Annex B, Intelligence.)

b. Friendly forces. Units to be supported, location and strength, with emphasis on those units engaged in protection of lines of communication and transportation units or activities, including higher, adjacent, and supporting units of both U.S. and allied forces.

c. Characteristics of the area of operations.

(1) Weather. Temperatures, wind conditions, rainfall, tide and river conditions, aeronautical weather information, etc.

(2) Terrain and hydrography. Critical terrain features, soil trafficability, beach gradients, any known obstacles, and possible effect on the transportation modes.

(3) Lines of communication. All lines of communication and physical condition.

d. Attachments and detachments.

e. Assumptions and policies. Any pertinent policies and logical assumptions needed in preparing the plan; for example, proposed locations of major unit boundaries, troop strengths to be supported in different phases of the operation, etc.

2. MISSION. Mission of transportation units in support of the command.

3. EXECUTION

a. Concept of operation. The transportation officer's overall concept of the operation, including probable increases in supported units, additional territory to be supported, etc. (Annex C, Concept of Operations.)

b. Rail. Specific tasks assigned rail units. (Projected loads, schedules, facilities, lines of communication, etc., are best submitted in the form of an annex to the plan.)

c. Motor.

d. Air.

e. Water.

f. Inland waterway.

g. Transportation movements.

h. Staging areas.

i. Transportation depots.

j. Pipelines (even though not operated by transportation units).

k. Troop carrier space. Proposed use of air capacity allocated to the command although transportation organizations do not assign tasks. (As indicated in b above, similar information for each mode of transportation is best submitted in the form of an annex to the plan, the format of which should parallel that of the plan itself so far as practical.)

l. Coordinating instructions.

(1) Defense and security. Reference to appropriate SOP or defense plan.

(a) Individual.

(b) Facilities.

(c) Lines of communication.

(d) Shipments.

(e) Censorship.

(f) Communications.

(2) Counterintelligence. Annex B, Intelligence.

(3) Technical intelligence. Annex B, Intelligence.

(4) Effective time and date.

4. ADMINISTRATION AND LOGISTICS

a. Administration.

(1) Policies. References to paragraph 1c above.

(2) Procedures. SOPs and related guides of higher headquarters not covered elsewhere in the plan.

(3) Required reports.

b. Logistics.

(1) Transportation supply. The following times are covered by reference to current SOPs when applicable.

- (a) Levels of supply.
- (b) Replacement factors and consumption rates.
- (c) Requisition procedures and cycles.
- (d) Emergency requisition procedures.
- (e) Local procurement.
- (f) Controlled items.
- (g) Surplus material.
- (h) Captured material.
- (i) Salvage and scrap.
- (j) Interservice supply.
- (k) Class IV equipment.
- (l) Equipment out of commission for parts procedures.
- (2) Supply support of transportation mission by other services.
- (3) Transportation maintenance. Maintenance facilities, indicated by mode, shop locations, and responsibilities of each maintenance unit.

c. Personnel.

- (1) Policies.
 - (a) Use of local civilian personnel.
 - (b) Use of prisoners of war.
 - (c) Use of U.S. civilian personnel.
- (2) Strengths.
- (3) Replacements.
- (4) Procedures.

5. COMMAND AND SIGNAL

a. Annex—Signal.

b. Command.

- (1) Location of CPs of major commands.
- (2) Locations of transportation movements branches.

ACKNOWLEDGMENT INSTRUCTIONS.

Commander (name and grade)

Annexes

Distribution

Authentication

6-12. Feasibility Test for Transportation Plan

1. GENERAL

a. This test is prepared to enable transportation staff planners to check the feasibility of a transportation plan (annex to administrative orders, letter of instructions, etc.) after the plan has been prepared.

b. The test has been prepared in checklist form. Paragraph 2 gives general considerations which apply to all modes of transportation, and the

remaining paragraphs lists items which apply to a specific mode. Some items which appear in the remaining paragraphs may seem to belong under the general paragraph; however, these items represent abnormal conditions which may have a drastic effect on that mode.

c. In using the checklist, consider the items listed in paragraph 2 for each mode in addition to the paragraph that applies to that mode.

2. GENERAL CHECKLIST ITEMS

a. Calculated risks. Calculated risks involved. Effect on the mission. Governing factors.

b. Weather and terrain. General considerations. Favorable or adverse effect on the mission.

c. Enemy action. Consideration of enemy guerrilla action, clandestine action, etc.

d. Political and economic situation. Interference with local economy: Friendly or unfriendly attitude of the civil population.

e. Transportation net. Integration of elements of the transportation net. Portions of the net reserved for civilian use. Emergency procedures for joint civil-military use. Engineer construction service support of the present net and future operations.

f. Allocation and utilization of modes. Optimum utilization of transport capacity. Utilization of supporting services' capacities. Allocation to modes of tasks commensurate with their capabilities and equipment. Adequate provisions for retrograde cargo.

g. Logistical support of operations. Support of modes in sufficient quantity and time to accomplish the mission; e.g., POL products, repair parts, etc.

h. Task organization.

(1) Clear definition of command relationships, missions, and functions.

(2) Troop list assignments consider

(a) Strength.

(b) Training.

(c) Morale.

(d) Available transport equipment.

i. Local civilian and prisoner-of-war labor. Availability of civilian and prisoner-of-war labor in the skills required. Requirement for mobile civilian labor units for phase II and phase III operation. Adequate administrative and logistical support.

3. MOTOR TRANSPORT

a. Requirements versus capabilities.

b. Traffic circulation plan

- (1) Road net supports planned traffic.
- (2) Requirement for additional highway regulation personnel.
- (3) Adequate road repair and road maintenance support.
- (4) A designation of routes (restricted, dispatch, etc.).
- (5) Possible joint use of road net; i.e., can both combat forces (U.S. and/or allied forces) and civilian traffic use it simultaneously?
- (6) Availability of hardstand, maintenance areas, truck parks, relay stations, transfer points.
- (7) Marked routes, availability of marking signs.

4. RAIL

- a. Requirements versus capabilities.
- b. Unusual weather or terrain factors
 - (1) Are heavy rains due that may cause washouts, floods, or landslides?
 - (2) Is extreme subfreezing weather due?
- c. Engineer maintenance and construction support for rehabilitation or for major repair of rail line.
- d. Yards, roundhouse, repair shops.
- e. Suitable water and fuel supplies (if steam locomotives are to be used).
- f. Limiting factors:
 - (1) Bridge, weight, and clearance.
 - (2) Tunnel clearance.
 - (3) Roadbed and trackage.
 - (4) Rolling stock—condition, power, gage.
 - (5) Locomotives—condition, power gage.
 - (6) Train operations communications.

5. INLAND WATERWAY

- a. Check requirements versus capabilities.
- b. Weather and terrain. Freezeup or flood periods, tidal ranges, currents, fogs.
- c. Obstructions. Low bridges, types of drawbridges. Natural obstructions such as heavy weeds that might foul propellers.
- d. Locks. Locks controlled by assigned permanent personnel or the individual inland-waterway craft. Size of locks, time to pass through.
- e. Channels. Required maintenance. Size, depth, and width.
- f. Navigational aids. Sufficient fixed or mobile navigational aids for full utilization, day and night.
- g. Requirement for intermediate transfers.

- h. Condition of available craft.
- i. Marine inland-waterway repair and maintenance support.
- j. Inland-waterway facilities, docks, cranes.

6. PORTS AND BEACHES

- a. Check requirements versus capabilities.
- b. Port facilities:
 - (1) Floating cranes for heavy lifts.
 - (2) Piers, docks, warehouses, open ground areas.
 - (3) Road and rail nets.
 - (4) Navigational aids.
 - (5) Protected anchorage areas.
 - (6) Utilities (electricity, etc.).
 - (7) Harbor craft.
 - (8) Berth space, lengths, and depths.
- c. Beach facilities:
 - (1) Anchorage areas.
 - (2) Routes of ingress and egress.
 - (3) Road and rail nets.
 - (4) Hardstand and open ground areas.
 - (5) Equipment (forklifts, cranes, etc.).
- d. Weather and terrain:
 - (1) Ports:
 - (a) Tides and currents.
 - (b) Underwater obstructions.
 - (2) Beaches:
 - (a) Tides, currents, surf, gradient, tidal range.
 - (b) Underwater obstructions.

7. TRANSPORTATION MOVEMENTS

- a. Sufficient teams accomplish transportation movements mission.
- b. Adequacy of transportation movements plan to accomplish the mission. Flexibility or rigidity.
- c. Location of teams located for maximum utilization.
- d. Establishment of documentation procedures insure accomplishment of mission.

8. STAGING AREAS

- a. Capability of processing planned workloads.
- b. Adequate facilities.

9. TRANSPORTATION DEPOTS

- a. Ability to support the mission.
- b. Adequate facilities.

10. AIR

- a. Check requirements versus capabilities.
- b. Marginal weather:
 - (1) Low ceilings.
 - (2) Low visibility.
 - (3) Ice conditions (on ground) determining maintenance and time required to melt, plus closed hangar area.
 - (4) Temperatures to be encountered.
- c. Terrain: Altitudes to be encountered (temperature and altitudes affect lift capabilities).
- d. Navigational aids:
 - (1) Possibility of day and night operations.
 - (2) Ground stations:
 - (a) Ground controlled approach (GCA).
 - (b) Radio range.
 - (c) Instrument landing systems.
 - (d) Omnidirectional range (Omni range).
 - (e) Radar plotting station.
 - (3) Airborne navigational equipment.
- e. Communications: Adequacy of unit communications, augmentation required.
- f. Restrictions to flight:
 - (1) Maintenance of established air routes, including consideration of fire lanes.
 - (2) Degree of air superiority.
 - (3) Arrangements for weather reports from Air Force.
- g. Adequacy and location of landing sites or airfields, plus facilities at such locations.
- h. Maintenance:
 - (1) Condition of aircraft (number of hours previous operation).
 - (2) Maintenance units available.
 - (3) Repair parts available.
 - (4) Location and stock of depot support.
- i. Degree of training of supported units in use of logistical air support.

11. FLEXIBILITY

- a. Provision for rerouting or diversion.
- b. Interchange points.
- c. Transfer points.
- d. Substitution of one mode for another.
- e. Capability of handling emergency transportation tasks.

CHAPTER 7

MISCELLANEOUS

Section I. THE TRANSPORTATION BRIGADE

7-1. General

The transportation brigade is a major subordinate unit of the field army support command (FASCOM) (fig. 7-1). It provides Army-wide transportation service primarily in support of the field army supply and replacement distribution system. However, at the direction of the field army commander, it may also provide tactical mobility transport. The FASCOM commander controls all allocation and use of the brigade's transport capability through the FASCOM movements program. (For detailed information concerning the transportation brigade, see FM 55-9.)

7-2. Mission

The mission of the transportation brigade is to provide the following services to all users of transportation in the field army.

- a. Long-haul motor transport and, as required, local delivery of personnel and cargo.
- b. Airlift capability for select cargo, person-

nel replacements, and patient evacuation, as required.

- c. An augmentation for the operation of the field army highway traffic regulating system.
- d. Movement planning and management for the field army.
- e. Terminal transfer services, as required.
- f. Transport for airdrops of personnel and material, as required.

7-3. Capabilities

The transportation brigade, with its assigned units, has the following approximate daily transport capabilities.

- a. Movement of 1,350 tons of cargo by air.
- b. Movement of 13,000 tons of cargo by motor transport in long-haul operations (para 7-4).
- c. Transfer of 2,700 tons from one carrier to another. (Included in this capability is the temporary holding of in-transit cargo.)

7-4. Unit Capabilities (TOE) of Transportation Truck Companies ¹

Type of truck company	TOE	Type of equipment	Pieces of equipment authorized	Pieces of equipment available	Local hauls		Line haul	
					Trips per day	Ton or gallons per day	Trips per day	Tons or gallons per day
Light -----	55-17	2½-ton truck -----	60	45	4	720	2	360
		5-ton truck -----	60	45	4	1,080	2	540
Light-medium ----	55-67	5-ton tractor -----	10	7				
		12-ton stake and platform semi-trailer.	20	14	4	360	2	192
		2½-ton truck -----	60	45	4	720	2	384
Medium -----	55-18	5-ton tractor -----	60	45				
		12-ton stake and platform semi-trailer.	120	90	4	2,160	2	1,080
		5,000-gallon tank semitrailer -----	60	45	4	900,000	2	450,000
		7½-ton reefer semitrailer ² -----	60	45	4	1,080	2	540
Heavy -----	55-28	10-ton tractor -----	24	18				
		50-ton transporter ² -----	24	18	4	2,880	2	1,440

¹ See FM 55-35 for detailed planning information on overload, off-highway, maximum sustained, and other types of operations.

² Tonnage factors are based on average payload capacities for general planning.

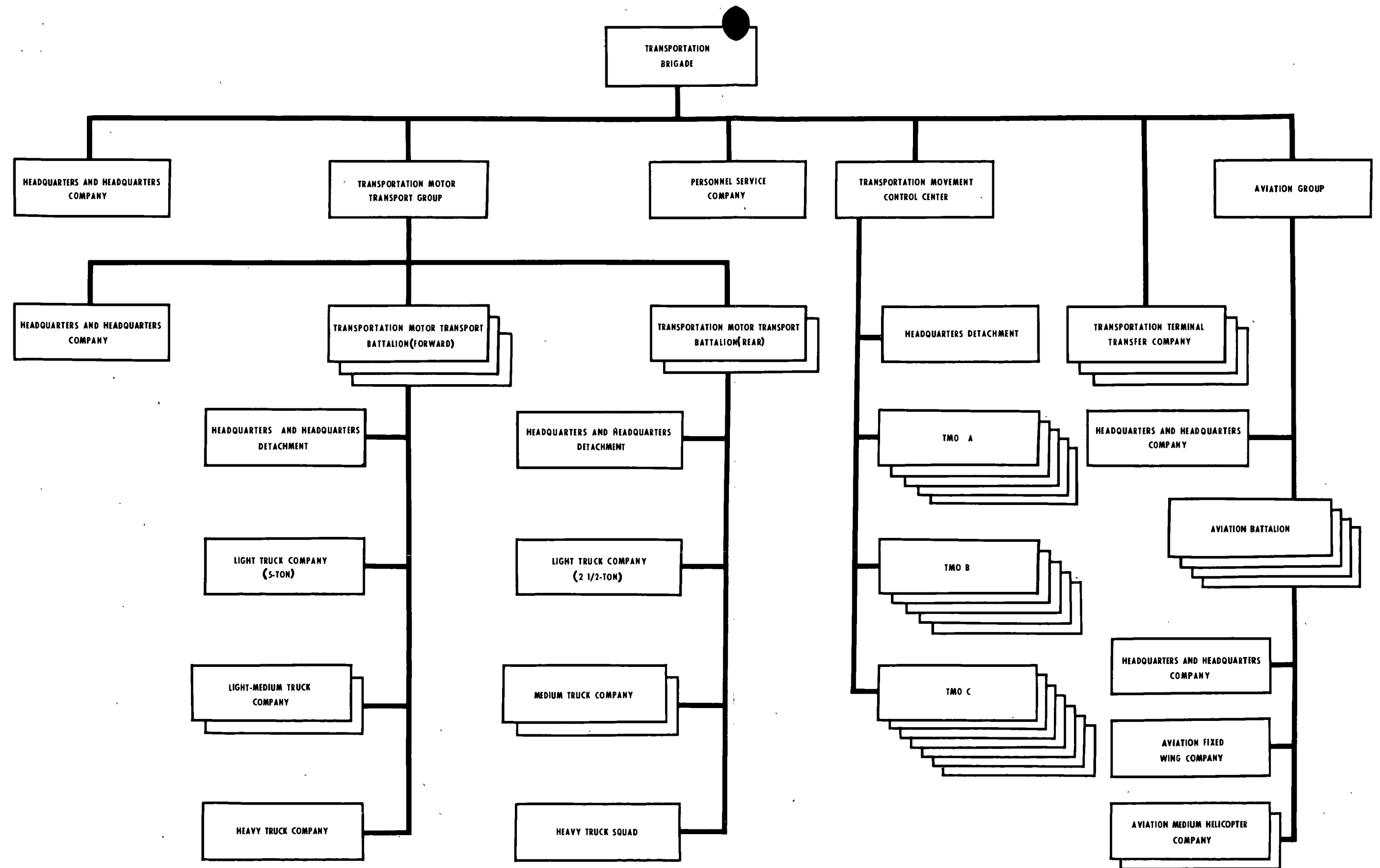


Figure 7-1. Transportation brigade.

Temperature Chart for Arctic and Subarctic Areas

Location	North Latitude		January		February		March		April		May		June		July		August		September		October		November		December		Snow Cover (in.)		Mean annual precipitation (in.)			
	Deg	Min	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Maximum depth and month	Average yearly depth for periods shown	Snow	Rain	Total	
Alaska:																																
Anchorage - - -	61	10	-40	+49	-45	+49	-25	+54	0	+64	+20	+84	+35	+84	+40	+84	+30	+84	+20	+74	0	+64	-20	+54	-35	+44	27.8 (Jan)	6.39 (Oct-Mar)	- - -	- - -	14.3	
Aniak - - - - -	61	35	-65	+49	-60	+49	-45	+54	-30	+59	- 5	+74	+30	+84	+30	+94	+20	+84	+10	+69	-20	+64	-40	+54	-55	+44	32.3 (Jan)	6.85 (Oct-Apr)	- - -	- - -	19.0	
Barrow - - - - -	71	18	-55	+29	-55	+24	-45	+29	-35	+34	-15	+39	+15	+64	+25	+74	+20	+74	+ 5	+64	-15	+44	-40	+39	-50	+29	22.5 (Mar)	10.70 (Sep-May)	- - -	- - -	5.3	
Barter Island -	70	7	-50	+34	-60	+24	-40	+34	-40	+34	-15	+44	+20	+64	+25	+74	+25	+64	+ 5	+64	-20	+44	-55	+39	-50	+34	- - - - -	- - - - -	- - -	- - -	5.0	
Big Delta - - -	64	0	-60	+49	-60	+49	-40	+54	-20	+69	+15	+89	+20	+89	+35	+94	+20	+84	+ 5	+74	-20	+59	-45	+54	-60	+39	54.3 (Jan)	11.20 (Sep-May)	- - -	- - -	15.0	
Cordova - - - -	60	30	-25	+49	-35	+44	-15	+59	+ 5	+64	+20	+79	+30	+79	+35	+84	+30	+79	+20	+69	+15	+74	-15	+54	-20	+49	29.0 (Jan)	8.05 (Oct-Apr)	132	131.8	145.0	
Fairbanks - - -	64	49	-60	+39	-60	+44	-40	+54	-20	+69	+15	+89	+30	+94	+35	+94	+20	+84	+10	+74	-15	+64	-40	+49	-60	+34	54.3 (Jan)	9.67 (Sep-May)	- - -	- - -	11.9	
Galena - - - - -	64	43	-60	+39	-60	+39	-45	+54	-30	+64	- 5	+84	+30	+89	+40	+89	+30	+84	+15	+69	-15	+59	-50	+44	-60	+39	- - - - -	12.87 (Oct-Apr)	- - -	- - -	17.0	
Kotzebue - - - -	66	52	-45	+34	-50	+39	-40	+34	-25	+44	-20	+74	+20	+84	+30	+84	+30	+79	+15	+74	-10	+54	-35	+39	-45	+34	48.3 (Mar)	13.19 (Sep-May)	- - -	- - -	9.0	
Nome - - - - -	64	30	-45	+39	-50	+54	-40	+44	-25	+54	-15	+69	+25	+79	+30	+74	+25	+74	+15	+64	- 5	+59	-40	+44	-45	+39	74.0 (Mar)	15.70 (Oct-May)	- - -	- - -	17.4	
Umiat - - - - -	69	22	-60	+34	-60	+29	-55	+39	-50	+59	-25	+59	+20	+74	+30	+89	+20	+79	- 5	+64	-30	+49	-55	+44	-60	+34	22.5 (Mar)	10.70 (Sep-May)	- - -	- - -	5.0	
Wales - - - - -	65	37	-35	+34	-40	+44	-35	+39	-25	+44	- 5	+59	+20	+64	+35	+69	+30	+74	+25	+54	+10	+49	-15	+44	-30	+34	74.0 (Mar)	15.69 (Oct-May)	- - -	- - -	10.5	
Wiseman - - - -	67	26	-60	+39	-60	+34	-40	+39	-30	+49	- 5	+79	+30	+84	+35	+89	+25	+79	+ 5	+59	-25	+44	-45	+34	-55	+29	- - - - -	- - - - -	- - -	- - -	7.5	
Canada:																																
Aklavik - - - - -	68	14	-50	+29	-60	+44	-40	+44	-35	+59	-15	+74	+20	+84	+35	+84	+30	+79	+15	+69	-15	+59	-40	+39	-55	+39	48.0 (Mar)	14.10 (Oct-Apr)	40.0	5.0	9.0	
Alert - - - - -	82	30	-55	+ 9	-50	+14	-50	+ 9	-40	+29	-15	+44	+15	+59	+25	+69	+ 5	+54	-15	+44	-30	+19	-40	+24	-50	+ 9	- - - - -	- - - - -	10.0	Neg	1.0	
Arctic Bay - - -	73	0	-45	+24	-55	+34	-50	+24	-40	+29	-10	+39	+15	+59	+30	+64	+30	+59	+10	-49	-15	+34	-40	+34	-40	+14	13.0 (Mar)	8.55 (Sep-Apr)	40.0	3.0	7.0	
Baker Lake - - -	64	18	-50	+ 1	-50	+14	-30	+19	-35	+34	-15	+39	+15	+59	+30	+74	+30	+69	+15	+49	-10	+39	-30	+29	-40	+19	17.5 (Apr)	10.34 (Nov-Apr)	50.0	6.0	11.0	
Cambridge Bay -	69	7	-55	+19	-55	+14	-45	+19	-40	+24	-15	+44	+15	+64	+30	+69	+25	+64	+10	+54	-20	+39	-40	+24	-50	+19	17.0 (Apr)	9.31 (Sep-May)	36.0	4.0	7.6	
Chesterfield - -	63	20	-50	+34	-55	+29	-50	+29	-40	+39	-20	+44	+10	+74	+30	+84	+30	+74	+15	+59	-10	+49	-35	+39	-50	+24	32.0 (Dec)	13.54 (Oct-May)	53.0	6.0	11.3	
Clyde - - - - -	70	27	-40	+14	-45	+24	-45	+24	-30	+19	-10	+39	+20	+44	+25	+59	+25	+59	+20	+44	- 5	+34	-20	+34	-40	+19	25.0 (Apr)	14.82 (Feb-Apr)	65.0	4.0	10.5	
Coppermine - - -	67	49	-55	+14	-55	+29	-45	+29	-35	+39	-15	+64	+15	+84	+30	+84	+30	+79	+15	+69	-25	+59	-40	+34	-40	+24	69.0 (Apr)	18.82 (Oct-May)	40.0	5.0	9.0	
Coral Harbor - -	64	12	-55	+ 9	-55	+29	-35	+24	-35	+29	-15	+39	+20	+54	+30	+79	+25	+69	+10	+49	-10	+34	-35	+34	-50	+29	40.0 (Feb)	17.81 (Oct-May)	59.0	5.0	10.9	
Dawson - - - - -	64	4	-60	+39	-60	+49	-35	+49	-40	+64	+10	+84	+25	+89	+35	+94	+25	+84	+15	+74	- 5	+64	-50	+49	-60	+44	45.0 (Feb)	15.13 (Oct-Apr)	45.0	7.5	12.0	
Eureka - - - - -	80	0	-60	+24	-60	+ 1	-60	+ 9	-50	+29	-20	+44	+10	+59	+30	+69	+15	+59	-15	+39	-45	+29	-50	+29	-60	+14	- - - - -	15.37 (Oct-May)	10.0	Neg	1.0	
Fort Providence	61	20	-60	+29	-55	+24	-40	+54	-25	+64	+10	+74	+25	+89	+35	+89	+25	+94	+ 5	+79	+10	+74	-40	+49	-60	+49	33.0 (Dec)	12.83 (Oct-Apr)	45.0	8.0	12.5	
Fort Smith - - -	63	1	-50	+44	-60	+54	-40	+49	+10	+84	-35	+79	+25	+89	+35	+99	+25	+94	+15	+84	- 5	+74	-35	+44	-55	+44	33.0 (Mar)	10.90 (Oct-Apr)	42.0	8.5	12.7	
Frobisher Bay - -	63	45	-53	+44	-50	+39	-45	+39	-30	+39	-15	+54	+15	+69	+30	+79	+20	+74	+15	+59	- 5	+44	-35	+29	-35	+34	74.0 (Mar)	21.10 (Oct-Apr)	80.0	7.5	15.5	
Holman Island - -	70	30	-45	+ 9	-45	+19	-35	+19	-25	+39	- 5	+39	+20	+69	+30	+74	+25	+64	+10	+44	0	+34	-25	+19	-30	+ 9	16.0 (Mar)	5.73 (Oct-May)	34.0	3.5	6.9	
Isachsen - - - -	78	47	-60	+19	-60	+ 6	-60	+ 9	-40	+29	-15	+34	+10	+54	+25	+64	+10	+59	-10	+34	-30	+29	-45	+19	-55	+14	- - - - -	- - - - -	10.0	Neg	1.0	
Mould Bay - - -	76	14	-60	+ 9	-55	+ 1	-55	+14	-40	+29	-15	+34	+10	+59	+25	+59	+15	+59	-15	+39	-25	+29	-45	+24	-60	+14	- - - - -	- - - - -	15.0	1.0	2.5	
Norman Wells - -	65	17	-50	+24	-60	+24	-30	+49	-15	+59	-10	+74	+30	+89	+35	+89	+30	+89	+ 5	+69	- 5	+49	-35	+24	-55	+14	51.4 (Jan)	17.34 (Oct-Apr)	40.0	7.0	11.0	
Nueltin Lake - -	60	30	-50	+19	-55	+19	-40	+39	-35	+49	-10	+69	+25	+74	+40	+84	+35	+79	+15	+69	-20	+54	-30	+39	-40	+24	- - - - -	- - - - -	55.0	9.0	14.5	
Padloping Island	67	6	-50	+29	-50	+24	-45	+29	-25	+44	-15	+49	+15	+59	+25	+74	+25	+64	+ 5	+64	+ 5	+59	-35	+44	-40	+34	65.0 (Jan)	49.00 (Jan-Apr)	- - -	- - -	15.0	
Resolute - - - -	74	43	-55	+24	-55	+ 9	-55	+19	-35	+29	-15	+39	+10	+59	+30	+64	+15	+59	0	+44	-25	+34	-40	+29	-55	+19	25.6 (May)	12.44 (Oct-May)	30.0	1.0	4.0	
Snag - - - - -	62	22	-60	+34	-60	+44	-40	+54	-50	+59	0	+89	+25	+89	+30	+84	+25	+79	- 5	+74	-20	+59	-55	+34	-60	+34	- - - - -	- - - - -	60.0	8.0	14.0	
Watson Lake - - -	60	7	-60	+44	-60	+44	-40	+49	-20	+59	+20	+84	+25	+84	+35	+89	+20	+84	+20	+79	-20	+69	-40	+49	-60	+39	37.8 (Feb)	15.55 (Oct-Apr)	60.0	9.5	15.5	
Whitehorse - - -	60	43	-60	+44	-60	+49	-25	+49	-15	+59	+20	+84	+25	+84	+30	+84	+20	+84	+15	+79	+ 5	+59	-45	+49	-55	+49	21.8 (Feb)	6.73 (Oct-Apr)	50.0	9.5	14.5	
Yellowknife - - -	62	28	-60	+39	-60	+34	-40	+39	-25	+64	0	+69	+30	+84	+40	+89	+35	+89	+20	+69	0	+64	-30	+39	-50	+39	32.0 (Jan)	12.79 (Oct-Apr)	40.0	7.5	11.5	
Greenland:																																
Angmagssalik - -	65	37	- 5	+39	-10	+39	- 5	+49	0	+54	+15	+54	+30	+59	+30	+74	+30	+64	+25	+64	+15	+49	0	+54	-10	+44	- - - - -	- - - - -	- - -	- - -	15.0	
Daneborg - - - -	74	18	-25	+29	-35	+19	-35	+24	-20	+29	0	+49	+25	+54	+30	+54	+25	+59	+10	+44	-15	+34	-25	+24	-20	+14	- - - - -	- - - - -	- - -	- - -	8.0	
Dammarshavn - - -	76	46	-45	+34	-40	+34	-30	+19	-30	+29	- 5	+39	+15	+59	+25	+59	+20	+54	+ 5	+44	-20	+29	-30	+29	-35	+19	- - - - -	- - - - -	- - -	- - -	5.0	
Godhavn - - - - -	69	15	-20	+39	-20	+44	-15	+44	-15	+49	+10	+59	+25	+64	+35	+64	+20	+54	+25	+54	+10	+54	+ 5	+44	- 5	+44	74.4 (Apr)	13.87 (Oct-May)	- - -	- - -	7.5	
Godthaab - - - -	64	10	-10	+44	- 5	+44	- 5	+39																								

Section II. CAPABILITIES OF TRANSPORTATION MEDIUMS

7-5. Tonnage Requirements and Transportation Capabilities

For methods used to determine tonnage requirements, see FM 101-10. The figures given below are approximate and are to be used as guides only.

Medium	Tons per day		Adequate to maintain
	STON	LTON	
Highway: ¹			
Gravel	3,400		2 divisions
Medium condition	5,800		4 divisions
First-class	8,400		7 divisions
Railway, each way:			
Single track	4,000	3,570	3 divisions
Double track	12,000	10,700	9 divisions
Gasoline pipeline: ²			
6-inch	2,000	1,790	5 to 8 divisions
4-inch	930	830	3 divisions
Water terminal discharge rate: ³			
Average cargo ship	720	643	½ division
Across beach:			
Per 1,000 yards of beach	1,680	1,500	1 division plus

¹ Daily forward tonnage, assuming sustained operations, adequate road maintenance, and two-way traffic.

² The capacities of pipeline systems vary, depending on the size of pipe, gradient, location, and size of pumps, and type of construction. Welded commercial pipelines can be operated at much greater pressures than standard military lines which have flexible couplings.

³ Water terminal discharge rate of 1,440 STON per day required to adequately maintain 1 division slice. See also paragraph 5-22.

7-6. Animals

a. Dogs.

(1) Trained dogs may be used individually or in teams to transport cargo in arctic and subarctic areas. They also have limited use in temperature zones to carry messages and small packages of mail, usually in regions inaccessible to other means of transport. Dogs should be permitted to rest 10 minutes in each hour and should not be worked continuously for more than 16 hours per day. For planning purposes, towed loads should not exceed 100 pounds per dog although the heavier breeds are capable of loads of 200 pounds per dog on a flat surface with good traction. The Eskimo dog, or husky, is the one most commonly used in arctic and subarctic regions.

The German shepherd usually is used in temperate zones. The figures below are for normal operating conditions and vary widely under extremes of weather and terrain.

(2) On packed snow with good traction, an individual dog in a sled team has the following cargo-carrying capabilities. On soft snow, load and speed must be reduced 50 per cent.

	Pounds of load per dog ¹	Distance in hour ²	
		Km	miles
Flat	50	9.6	6
Hilly	50	4.8	3
Mountainous	50	1.6	1

(3) On hard surfaces with good traction, an individual dog has the following capabilities for carrying cargo packs, messages, and mail.

Terrain	Cargo pack	Messages or mail	Distance in hour			
			Cargo pack	Mi	Km	Messages or mail
			Km			Mi
Flat	35	5 percent	3.2	2	24	15
Hilly	30	of dog's	3.2	2	16	10
Mountainous	25	weight	1.6	1	8	5

¹ Includes weight of sled.

² Reduce 50 percent when load is doubled.

b. Pack Mules.

- (1) Height: 59 to 62 inches.
- (2) Weight: 1,000 to 1,200 pounds.
- (3) Rate of march: 3.5 to 4 miles (5.6 to 6.4 kilometers) per hour.
- (4) Capacity: 200 to 250 pounds.
- (5) Movement of casualties: 1 litter or 2 sitting casualties.
- (6) Forage: 10 pounds of oats and 14 pounds of hay per day. May be reduced for short periods up to 10 days without impairing capacity.
- (7) Water: 10 gallons per day.
- (8) Noneffective rate: 3.2 percent.
- (9) Average daily distance:
 - (a) Mountains terrain—12 miles (19 kilometers).
 - (b) Rolling or flat terrain—24 miles (39 kilometers).
- (10) Gradeability:
 - (a) Rate of ascent—1,650 vertical feet (503 meters) per hour.
 - (b) Rate of descent—1,000 vertical feet (305 meters) per hour.

c. Transportability.

Vehicle	Capacity (horses or mules)
Trailer, 2-horse van	2
Truck, 1½-ton, cargo	2
Truck, 2½-ton, cargo	4
Semitrailer, 6-ton, combina-	
tion animal and cargo	8
Railroad stock car, 40-foot ...	25, approximately
Railroad stock car, 36-foot ...	20 to 22, approximately
Airplane, cargo transport	4 to 6*

d. Horse-Drawn Carts. Capable of traveling 20 miles (32 kilometers) per day drawing a payload of 1,000 pounds.

7-7. Human Bearers

For planning purposes, the following may be assumed.

a. Average Cargo Loads.

- (1) Male bearer—80 pounds.
- (2) Female bearer—30 to 35 pounds.

b. Personnel Loads. 8 to 12 bearers per litter team.

c. Rate of March. For average conditions on level terrain—12 miles per day. To estimate the time needed to cover a given distance in hilly or mountainous areas, use the following relationship. For these conditions, cargo loads shown in *a* above, should be reduced from 20 to 30 percent, depending upon steepness of the terrain.

$$T = t + a + d$$

where:

T = total time required

t = time required to march a given map distance

$a = \frac{\text{total ascent in feet during march}}{1,000}$

$d = \frac{\text{total descent in feet during march}}{1,500}$

*May be transported at altitudes up to 18,000 feet with no ill effects.

d. Overloading and Speed-Up. Overloading and speeding up operations increase the sick rate and cause desertion.

e. Noneffective Rate. Approximately 30 percent.

f. Supervision. Close supervision is required to prevent pilferage.

Section III. DIMENSIONS AND WEIGHT DATA**7-8. Unit Equipment**

TB 55-46 provides staff command and field organizations with validated dimensions, weight, and cube of Army vehicles and equipment for standard reference use in planning and in the submission of movement require-

ments to transportation agencies. The data presented are in accordance with the requirements of MILSTAMP (DOD Reg 4500.32R) for uniform and standard transportation data applicable to all cargo movements in the Department of Defense transportation system.

7-9. Packaged Missiles and Other Special Ammunition

Weapon	Container and contents	Container dimensions (in.)			Cubs (cu ft)	Gross weight (lb)	Remarks
		Length	Width	Height			
Hawk	Complete round	216	28	42		3,270	
	Guidance section	90	29	34		715	Data applicable only when guidance section is shipped separately.
	Igniter, rocket motor	29 1/4	19 3/16	18 11/32	5.96	155	Packed 24 in wooden box.
	Safety and arming device, GM XM32E4 and XM326	28 1/6	14 1/16	10 25/32	2.46	72.3	Packed 8 in wooden box.
	Igniter electrical power unit	17 1/8	12 3/16	10 31/32	1.32	35	Packed 24 in wooden box.
	Propellant grain, EPU	24 1/8	15 15/16	14 7/32	3.16	65.6	Packed 24 in wooden box.
	Propellant grain, inert EPU	24 1/8	15 15/16	14 7/32	3.16	65.6	Packed 24 in wooden box.
	Explosive release device	31 1/8	23 9/16	10 3/32	4.32	54.5	Packed 24 in wooden box.
	Accumulator, hydraulic, pneumatic (squib activated)	20	20	29	6.50	88	Packed 1 to metal drum.
	Guidance section	90	29	34	51.35	715	Metal shipping container. Data applicable only when guidance section is shipped separately.
Nike-Ajax	Warhead, M2	15 1/4	7 7/8	10	1.7	35.42	Wooden box (2 per box).
	Warhead, M3	28 1/4	13 1/2	16 3/8	3.6	212	Wooden box (1 per box).
	Warhead, M4	26 5/8	12 3/4	16 1/8	3.2	153	Wooden box (1 per box).
	Body, guided missile: M2 or M2E1	266	38 1/4	41	240.4	2,495	Reusable metal container (1 per metal container M326).
	Fin, rocket motor, M12	42 1/4	40 3/4	12 3/4	12.6	166	Wooden box (3 per box).
	Fin, control and stabilizer	76 1/4	22 1/8	27	26.5	220	Wooden crate (4 M9 fins and 4 M10 fins per crate).
	Rocket motor, M5, packed in container M13 or M13A1 w/thrust structure, M2 and igniter M24 or M65 or M69	177	25 1/4	31 1/2	81.5	1,883	Wooden crate.
	Igniter, rocket motor, M24 or M65 or M69	25 1/8	16 1/4	17 1/8	4.0	202	Wooden box (18 per box).
	Antenna: frequency band pass	42 3/8	11 1/4	20 3/4	5.7	81	Wooden box.
	Battery: BB401/U	19 5/16	13	10 5/8	1.5	65	Wooden box (4 per box).
	Delay line	18	14 1/2	8	1.2	41	Wooden box.
	Explosive harness assembly						
	guided missile	24 3/4	15	8 1/4	1.7	36.5	Wooden box (10 per box).
Nike-Hercules	Body section, guided missile, fore and aft	223 1/2	54 3/4	61 1/2	435.5	4,606	Reusable container, metal, M410.
	Warhead section, GMHE, M135 with warhead M17 (T45) or M17A1 (T45E1)	99 1/4	54 3/8	61 1/2	192.1	3,170	Reusable container, metal.

Weapon	Container and contents	Container dimensions (in.)			Cube (cu ft)	Gross weight (lb)	Remarks
		Length	Width	Height			
Nike-Hercules (Cont)	Rocket motor, M30	107	43 1/4	47 7/16	124.8	3,844	Wooden crate.
	Rocket motor, M5E1 or M88, packed with igniter, rocket motor, M24 or M65 or M69 ..	177	25 1/4	31 1/2	81.5	1,883 1,949	Wooden crate.
	Rocket motor, M42 w/4 igniters, M24 or M65 or M69	180 3/8	46 9/16	55 11/16	270.7	6,520	Wooden crate.
	Igniter, rocket motor, M24 or M65 or M69	23 1/2	15 1/4	14	2.9	110	Wooden box (12 per box).
		25 1/8	16 1/4	17 1/8	4.0	202	18 per box.
	Squib, electric, for igniter, rocket motor, M30 (TX-345)	19	9 1/2	7 1/4		0.75	Wooden box (24 per box).
	Safety and arming device, guided missile, M30A1	15 1/2	9 1/4	8	6	25	Wooden box (20 per box).
	Fin assembly, M20, attach hard- ware	51 1/4	29 1/2	51 3/4	45.4	581	Wooden box.
	Horn waveguide	17 1/2	11 1/4	13 1/4	1.5	25	Wooden box (18 per box).
	Battery, BA472/U	17	22 1/16	9	2.8	172	12 units per pack.
		11 1/16	9 1/2	5 1/8	.3	15	1 unit per pack.
	Battery, BA485/ U	34 1/8	19 7/8	15 1/4	7.7	160	2 units per pack (wooden box).
		19 3/4	17 1/8	15 1/4	4.2	70	1 unit per pack (wooden box).
	Booster thrust assembly w/hard- ware	38 5/8	38 3/4	46 1/4	38.6	321	Wooden box.
	Delay lines	15 1/2	9 1/4	9 1/4	.8	20	Wooden box, confidential, for handling, shipping, and storage or issue. See AR 380-55.
	Ethylene oxide "propellant," MPP574	51	15 1/2	15 1/2	6.89	280	Steel cylinder.
	Explosive harness assembly, guided missile XM38 or XM84	29 1/4	21 1/4	13 15/16	4.8	37.34	Wooden box.
	Fin assembly, rocket motor, w/clustering components	62 5/16	29 5/16	51 3/4	54.3	644	Wooden box.
	Control surface kit, guided mis- sile	147 1/2	29	42 1/8	104.28	1,050	Wooden box containing 4 main fins, 4 center fins, and 4 elevons.
Little John	Rocket motor, M26 for 318mm rocket, M51	126	44	38 11/16	1124.52	1,377	Packed 1 to reusable metal container, M455.
	Warhead section, M8 "practice" for 318mm rocket, M51	100	28 1/2	34 1/2	56.90	948	Packed 1 to reusable metal container, M477.

Battery (thermal), BA605/U ..	16 1/4	8 1/16	8 1/8	.6	20	Wooden box.
Battery and switch assembly for rocket motor, M26, 318mm rocket, M51	26 9/16	14 9/16	14 25/32	3.3	63	4 battery and switch assem- blies packed in 1 container; 4 containers in wooden box.
Charge spotting M93 for war- head "practice," M8, 318mm rocket, M51	29 7/8	10 11/16	9 27/32	1.7	40	Wooden box (12 per box).
Explosive harness assembly, M90 and 318mm rocket, M51	21 3/4	15 1/4	15 5/8	3.0	100	Wooden box (20 per box).
Fuze, rocket, MT, M421 (T-2075E1), 318mm rocket, M51	25 1/4	19 15/16	11	3.3	115	Wooden box (20 per box).
Igniter, rocket motor, M57 for 318mm rocket, M51	45 7/18	3 1/2	3 1/2	.32	54	Metal case (1 per case).
Primer assembly, warhead, M8...	39	26 1/16	10 3/32	6.0	85	Wooden box (100 per box).
Igniter, rocket motor, M57	49 5/8	6 1/6	6 25/32	1.2	23.1	Wooden box (1 per box).
	50 3/16	10 1/2	11 5/32	2.9	88	Wooden box (4 per box).
Warhead section, XM477	100	28 1/2	34 1/2	59.60	948	Packed in reusable metal con- tainer, M8 and M8E1.
Rocket motor, M26 for 318mm rocket, M51	141	39	45	143.83	2,120	Packed in reusable metal con- tainer, M948.
Honest John						
Rocket motor, 762mm, M3 series	239 1/2	41 1/2	49	281.85	6,538	Wooden crate.
Rocket motor, 762mm, M66 w/4 fins, M17	235	42 1/8	49	269.26	5,883	Wooden crate.
Rocket motor, 762mm, M66A1 w/4 fins, M17	198 1/16	41 5/8	47 3/8	206.05	4,801	Wooden crate.
Rocket motor, 762mm, M6 w/ igniter	205	34	38	153	4,740	Wooden box.
Rocket motor, 762mm, M7 series	19 1/2	10 1/8	12 5/8	1.4	66	Wooden box packed 8 per lum- ber sheathed container.
Rocket motor, 762mm, M37 series	14 5/8	13 1/16	19	2.10	55.70	Wooden box packed 4 per lum- ber sheathed container.
Warhead assembly, 762mm, rocket "empty," M1 series ...	146	49 5/8	56 1/2	236.9	1,922	Wooden crate.
Warhead section, 762mm rocket, flash-smoke, M1A2 w/warhead, XM4 series and 2 ea fuze, MT, M411	146	49 5/8	56 1/2	236.9	3,410	Wooden crate.
Fin, 762mm rocket, M136 series	60 5/8	16 3/4	49 7/8	29.31	345	Wooden box.

Weapon	Container and contents	Container dimensions (in.)			Cube (cu ft)	Gross weight (lb)	Remarks
		Length	Width	Height			
Honest John (Cont)	Igniter, rocket motor, M35 series	25 1/2	16 5/8	8 5/8	2.10	41.8	Wooden box packed with 6 cans, 1 igniter per can.
	Igniter, rocket motor, M58A1 ..	35	17 1/8	17 13/32	6.23	144	Wooden box packed with 2 cans, 1 igniter per can.
	Igniter, rocket motor, M58	35	17 1/8	17 13/32	6.23	139	Wooden box packed with 2 cans, 1 igniter per can.
	Fuze, rocket, MT, M421 (T2075E1)	25 1/4	19 15/16	11	1.6	55	Wooden box (20 per box).
	Pedestal, 762mm rocket, M2 series w/electrical installation, w/ or w/o battery	34 1/8	32 5/8	23 5/8	15.20	111	Wooden box.
	Pedestal, 762mm rocket, M3	31 1/16	31 1/16	23 3/16	11.6	118	Wooden box.
	Pedestal, 762mm rocket, M3A1 ..	31 1/16	31 1/16	23 3/16	11.6	118	Wooden box.
	Warhead section, 762mm rocket, practice, M38 w/warhead, 762mm rocket, M38 and 1 ea fuze, MT, M421	140 1/4	44 1/4	50 3/8	181	2,898	Wooden box.
	Warhead section, 762mm rocket, HE, M1A2 w/warhead, 762mm, HE, M57 (T39E4) and 1 ea S&A device, XM43 and 1 ea power supply Y155	146	49 5/8	56 1/2	236.90	3,410	Wooden box.
	Pedestal, 762mm rocket, M2 w/electrical installation and hardware w/ or w/o battery ..	59 1/8	32 5/8	49 5/8	55.33	272	Wooden box.
	Fin, 762mm rocket, M136 series	50	15 1/2	53 1/2	24.0	280	Wooden box.
	Sergeant						
	Rocket motor, XM53	209 3/4	47 1/4	44 5/8	255.94	8,000	Plywood sheathed container.
	Rocket motor, XM53 w/nozzle assembled	223 3/4	48 1/2	50 3/4	218.71	8,150	Reusable aluminum container, XM419.
	Body section (guidance) AN/ DJW-8, XM420	124 1/2	48 1/2	50 3/4	177.00	2,050	Reusable aluminum container, XM420.
	Body section, GM, XM38 w/ or w/o warhead (training)	164 1/4	48 1/2	50 3/4	234.0	2,470	Reusable aluminum container, XM421.
	Control surface assembly, XM58	55 1/2	35 1/2	12	13.7	125	Reusable aluminum container, case, XM123 (1 per case, 4 cases per missile).

Sergeant (Cont)	Body section, guided missile XM38 w/warhead (training) ..	146 1/2	41	50 3/4	175	3,000	Reusable steel container, XM481.
	Rocket motor	220 1/8	47 1/8	48 1/8	288.9	8,890	Reusable steel container, XM486.
	Body section (guidance) AN/DJW-8	107 1/4	47 1/8	47 3/8	138.56	2,170	Reusable steel container, XM487.
	Control surface assembly, XM94	55 1/2	38 1/8	12 5/8	15 1/8	172	Reusable aluminum container, XM123E1.
Pershing	Warhead section w/ or w/o inert or empty warhead	168	51 1/2	53	260	2,596	Packed in reusable metal container XM483.
	Guidance control section, GM ...	90	65	72	235	2,532	Packed in reusable metal container, XM474.
	First stage rocket motor, GM ...	145	65	70	381.8	9,193	Packed in reusable metal container, XM475.
	Second stage rocket motor, GM ..	145	65	70	381.8	7,365	Packed in reusable metal container, XM476.
	Case venting	50	7	12	2.4	32	Packed in reusable metal container, 2 each per container.
SS11	Complete round	40	28	24 1/2	6	157	Wooden crate.
SS11/B1	Complete round	36	19 1/4	20 3/4	8.3	110	Fiberglass container.
Redeye	3 complete rounds	55 1/4	21 1/4	20 1/4	10.4	144	Shipping and storage container, GM system XM547 (tripak).
Shillelagh	Complete round	51	14 3/4	14 3/4	6.4	709	Metal container.
Entac	Complete round	31	15	15 3/8	4.1	112	Wooden container.
Davy Crockett ...	Complete round	37 3/4	16	16	5.6	----	Wooden box (weight is classified).
XM454 projectile..	Complete round	57	22	20	14.5	220	

7-10. Materials Handling Equipment

The items of materials handling equipment listed below are those normally used by terminal service personnel. For the most part, these items are authorized by TOE or TA. The straddle trucks listed in *f* below normally are

not transportation TOE or TA items, but may be obtained by special authorization when needed. For more complete information, see TM 10-1619.

a. Forklift Trucks. (Gasoline power, pneumatic tires.)

Capacity (lb)	Lift height (in.)	Free lift (in.)	Fork length (in.)	Load center (in. from heel)	Weight (lb)	Dimensions (in.)		
						Height	Length	Width
3,500	144	----	--	24	6,770	108	120	78
4,000	144	22	40	24	7,660	95	104	45
6,000	168	6¾	40	24	10,375	115	113	68
10,000	210	2	48	24	14,145	150	136	77
15,000	210	2½	48	24	18,330	150	152	96

b. Rough-Terrain Forklifts.

Capacity (lb)	Lift (in.)	Fork length (in.)	Gradeability (percent)	Turning radius (ft)	Lift tilt (degrees)		
					Forward	Back	Left-right
6,000	144	48	45	15	45	30	10
10,000	144	60	45	17	45	30	10

c. Warehouse Tractors. (Gasoline power, pneumatic tires.)

Drawbar pull (lb)	Towing capacity (tons)	Loaded speed (mph)	Weight (lb)	Dimensions (in.)		
				Height	Length	Width
4,000	90	12	5,220	57	111	66
7,500	200	9.47	12,386	72	130	96

d. Warehouse Cranes. (Gasoline power, pneumatic tires.)

Capacity (lb)	Swing range	Loaded speed (mph)	Weight (lb)	Dimensions (in.)		
				Width	Length	Height
10,000	180°	15	20,800	95	295	94
10,000	180°	12	20,000	260	273	96

e. Warehouse Trailers.

Capacity (lb)	Tires	Construction	Dimensions (in.)	
			Length (in.)	Width (in.)
4,000	Steel or rubber	Wood	72	36
4,000	Steel or rubber	Wood	84	36
4,000	Steel or rubber	Wood	84	48
6,000	Pneumatic	Wood	108	48
20,000	Solid rubber	Steel	144	72

f. Straddle Trucks. (Gasoline power, pneumatic tires, four-wheel steering.)

Capacity (lb)	Loaded speed (mph)	Weight (lb)	Dimensions (in.)		
			Height	Length	Width
30,000	35	12,500	114	187	92
30,000	35	13,250	123	187	92
30,000	35	13,000	124	188	105
30,000	35	14,800	159	192	96

g. Crawler and Truck-Mounted Cranes. The chart below gives ratings and clearances and can be used to determine lifting capacity for different boom lengths and positions. The actual lifting capacity of any particular crane, for a given boom length and position, can be found on the vehicle nameplate or in the vehicle technical manual. The letters used in the chart indicate the following:

R = Radius (horizontal distance between end of boom and center of rotating table) in feet

A = Angle in degrees that boom makes with the horizontal

C = Lifting capacity in pounds

D = Distance in feet and inches between top of boom and ground

R	A	C	D	A	C	D	A	C	D
45-foot boom				50-foot boom			55-foot boom		
12	80	52,100	49' 9"	80	52,100	54' 10"			
15	76	37,100	49' 2"	77	36,800	54' 3"	78	36,600	59' 5"
20	69	24,500	47' 7"	71	24,300	52' 11"	73	24,100	58' 2"
25	62	18,100	45' 4"	65	17,800	50' 11"	68	17,600	56' 4"
30	55	14,200	42' 3"	59	14,000	48' 3"	61	13,800	54' 0"
35	46	11,600	38' 2"	51	11,300	44' 9"	56	11,100	40' 11"
40	36	9,700	32' 6"	43	9,400	40' 3"	49	9,200	47' 1"
45	24	8,200	24' 1"	34	7,900	34' 2"	42	7,800	42' 2"
50				23	6,800	25' 1"	33	6,700	35' 8"
55							22	5,800	26' 1"
60-foot boom				65-foot boom			70-foot boom		
20	75	23,900	63' 4"	76	23,700	68' 6"			
25	69	17,400	61' 9"	71	17,200	67' 0"	73	17,000	72' 3"
30	64	13,600	59' 7"	66	13,400	65' 1"	68	13,200	70' 6"
35	59	10,900	56' 11"	62	10,700	62' 8"	64	10,600	68' 3"
40	53	9,000	53' 6"	56	8,800	59' 8"	59	8,700	65' 7"
45	47	7,600	49' 4"	51	7,400	55' 11"	54	7,300	62' 3"
50	40	6,500	44' 1"	45	6,300	51' 5"	49	6,100	58' 3"
55	32	5,600	37' 2"	38	5,400	45' 10"	43	5,200	53' 6"
60	21	4,900	27' 1"	30	4,600	38' 6"	36	4,500	47' 6"
65				20	4,100	28' 0"	29	3,900	38' 10"
70							19	3,400	28' 10"

7-11. Telephone Poles

	1	2	3	4	5	6	7
Minimum top circumference (in.)	27	25	23	21	19	17	15
Transverse breaking loads (lb)	4,500	3,700	3,000	2,400	1,900	1,500	1,200

Type	Length (ft)	Average weight (lb)						
Western cedar	20	700	600	500	400	300	225	200
Northern cedar	20	720	600	540	350	300	230	190
Creosoted pine	20	635	555	479	418	353	310	259
Western cedar	25	850	720	600	480	400	320	250
Northern cedar	25	1,020	780	600	515	420	300	250
Creosoted pine	25	898	808	686	602	508	423	362
Western cedar	30	1,000	850	730	610	500	420	350
Northern cedar	30	1,320	1,170	870	630	520	420	350
Creosoted pine	30	1,241	1,076	921	780	672	573	489
Western cedar	35	1,200	1,000	850	750	650	560	470
Northern cedar	35	1,620	1,380	1,060	820	720	510	450
Creosoted pine	35	1,603	1,410	1,213	996	865	733	616

Western and northern cedars are furnished butt-treated; pine is treated full length. To estimate required shipping space, use the following formula.

$$\frac{\text{Average weight (lb)} \times \text{constant}}{40} = \text{measurement tons}$$

Values of the constants are: Cedar—0.052
Pine—0.026

Section IV. COLD WEATHER DATA

7-12. Sled Train

a. Power Vehicle Specifications.

Type	Gross weight (lb)	Cubic feet	Dimensions (in.)			Personnel	Fuel cap. (gal.)	Speed (mph)					Drawbar pull (lb)		Payload towed	Fuel consumption (avg)	Turning radius (ft)	Engine
			Length	Width	Height			Gear					Direct drive	Torque converter				
M29C								1	2	3	4	5						
Weasel ..	5,971	403	193	67.3	71	4	35	4	7	10	12	20	NA	None	3,800 lb	5 mpg	12	Studebaker
M76 Otter..	12,162	1,180	193	98	103.3	10	70	8	18	28	---	---	Cross drive	None	6,000 lb	2.3 mpg	12	Champion
								avg	avg	max								Continental Model, A01, 268-38
M116																		
Husky ..	7,880	----	182	80.5	79.5	12	65	---	---	---	---	---	-----	-----	-----	4.6 mpg	--	Chevrolet
D7 LPG ..	47,515	1,870	232	132	123.75	1	65	2	3	5	7	10	15,000	None	30 to 40 tons	135 gal. per day	24	Caterpillar D337
D8 LPG																		
M54	58,780	3,360	288	160	126	2	100	2	3	5	7	10	20,000	27,500	30 to 40 tons	135 gal. per day	24	Caterpillar D337
D8 LPG																		
M55	83,000	3,360	288	160	126	2	918	1.5	1.0	2.8	3.8	5.2	32,000	None	30 to 40 tons	135 gal. per day	24	Caterpillar D342

b. Sled Specifications.¹

Characteristics	1-ton recon sled		2½-ton farm sled	10-ton ATACO steel skis	10-ton ATACO Micarta skis	Fuel transporter
	1952	1953				
Gross weight (lb) -----	1,225	1,390	1,375	7,000	7,000	10,271
Cubic feet -----	75	128	282	1,867	1,460	403.92
Dimensions:						
Length -----	10' 9"	13' 10½"	15' 8"	22' 4" w/o	22' 4"	24'
Width -----	5'	7' 1½"	7' 2"	8' 6"	8' 6"	10'
Height -----	1' 5"	1' 4¾"	2' 6"	7' 3" to top of stakes	7' 8" to top	4' 6"
Capacity -----	2,000 lb	2,000 lb	2½ tons	10 tons	10 tons	3,021 gal.

¹ A plastic boat-type sled is also available and used extensively in northern areas. It weighs 38 pounds, is 88 inches long, 25 inches wide, and 8 inches deep, and has a 200-pound capacity.

c. *Wanigan Specifications.* A wanigan is a small house, normally constructed of plywood, lumber, and insulating material; usually

mounted on runners; and transported in tractor-drawn sled trains. Interior designs vary; it may be used as a kitchen, shop, bunkhouse, etc.

Characteristics	Command, M54	Passenger, M52	Passenger, M54	Command, M55	Crew, M53	Crew mess, M54	Crew, M55	Mess, M55
Weight, empty (lb) -	10,500 (est)	10,500 (est)	11,400 (est)	15,000	16,000 (est)	18,000	19,000	19,000
Cubic feet -----	1,560	1,560	1,870	2,600	3,310	2,868	3,790	3,790
Dimensions:								
Length -----	20'	20'	24'	26'	35'	45'	38'	38'
Width -----	10'	10'	10'	12'	8' 7"	8' 6"	12'	12'
Height -----	7' 2"	7' 2"	8' 6"	10' 3"	7' 8"	7' 6"	10' 3"	10' 3"
Number of persons accommodated ---	4	10	12	6	18	16	24	18
Fuel used -----	Diesel oil	Diesel oil	Diesel oil	Diesel oil	Diesel oil	Coal	Diesel oil	Diesel oil

d. Other Data.

(1) Fuel consumption per day.

(a) Coal stove for heating.

1. 20 pounds of coal or 12 Presto logs of summer operations (10° F. or above).

2. 50 pounds of coal or 30 Presto logs for winter operations (below 10° F.).

(b) Coal stove for cooking.

1. 50 pounds of coal, or

2. 30 Presto logs.

(c) Generator fuel consumption.

1. 5-kw generators burn approximately 20 gallons of gasoline in continuous operations.

2. 30-kw generators burn 30 gallons of diesel fuel oil (VVF 800).

3. 45-kw generators consume 35 gallons of diesel fuel oil (VVF 800).

(d) *Yukon stove for heating.* Burns 5 gallons of gasoline in a 10-12 hour period while heating the 10-man arctic tent in temperatures of 0° F. and lower. This stove will also burn wood or coal.

(e) *Starting motors or pumps.* Based on an average of 1 hour of operation per day, are rated at 0.2 gallon of gasoline.

(2) Lubrication consumption.

(a) Engine oil consumption of large, general-purpose tractors is rated at 2 gallons per day. The rate is considered equal for OE 30-10-5. The consumption rate for a light vehicle is 0.006 gallon per mile.

(b) The rate of gear oil consumption is 0.45 gallon per mile for a large, general-purpose tractor; 0.006 gallon per mile for a light vehicle.

(c) GAA is used as an all-purpose grease (also used for water pumps, etc.). Consumption rate is 0.005 pound per mile.

(d) Consumption rates for generators, starting motors, and pumps are based on operations listed in (1)(c) and (e) above.

(3) *Antifreeze.* Each vehicle will have its initial antifreeze put in before embarking on a cold-weather operation (para 7-14).

7-13. Load-Bearing Capacity of Ice

The strength of ice varies with the structure of the ice, the purity of the water from which it is formed, the cycle of formation (freezing, thawing, and refreezing), temperature, snow cover, water currents, and whether or not the ice is water supported. Although the sustaining capacity of ice cannot be determined accurately, experience and tests provide the working capacity figures given below for good quality freshwater ice.

Load	Ice thickness in CM ¹		Distance in meters between units ²
	Risk	Normal	
Single soldier on skis ---	4	5	5
File of soldiers 2-pace interval -----	8	10	
Vehicles:			
Truck, ¼ T -----	15	20	15
Truck, ¾ T -----	20	25	20
Truck, 2 ½ T -----	35	40	25
Truck, 5T -----	45	55	60

Load	Ice thickness in CM ¹		Distance in meters between units ²
	Risk	Normal	
Tractor and trailer loaded, ST -----	80	90	80
M116 -----	30	35	15
M113 -----	40	45	25
D7 tractor -----	45	50	40
D8 tractor -----	50	60	50
Crane, 20T -----	55	60	70
Grader -----	35	40	50
Tank M41 -----	50	65	60
SP M52 -----	55	65	50
APC M59 -----	45	55	50
Tractor M8A2 -----	55	65	70
Aircraft:			
UH-1A -----	20	25	
OH-13 -----	15	18	
CH-21 -----	30	35	
CH-37 -----	45	50	
O-1A -----	15	20	
U-6A -----	20	25	
U-8D -----	20	25	
U-1A -----	25	30	

¹ Multiply by .3937 to obtain inches.

² Multiply by 3.2808 to obtain feet.

7-14. Guide for Preparation of Antifreeze Solutions

Lowest expected ambient temperature (° F.)	Arctic grade antifreeze (-80° F.) (MIL-C-11755)	Ethylene-glycol antifreeze (-60° F.) (spec. O-E-771a, type I)		Denatured alcohol (grade III) ¹ Pints per gallon of coolant capacity ²
		Pints per gallon of coolant capacity ²	Specific gravity (68° F.)	
+20	Freezing point of -90° F. -----	1 ½	1.022	1 ½
+10	-----	2	1.036	2 ¼
0	Issued ready for use and must not be mixed with any other liquid ---	2 ¾	1.047	2 ¾
-10	-----	3 ¼	1.055	3 ¼
-20	-----	3 ½	1.062	3 ½
-30	-----	4	1.067	4 ½
-40	-----	4 ¼	1.073	5
-50	-----	4 ½	---	---
-60	-----	4 ¾	---	---

¹ Used as temporary emergency expedient when neither arctic grade antifreeze nor ethylene-glycol antifreeze is available.

² Includes heaters, etc.

7-15. Temperature, Snow Cover, and Precipitation in Arctic and Sub-Arctic Areas

The temperature chart below may be used as a guide for preliminary planning of operations in the areas shown, keeping in mind that seasonal storms may cause some of the figures to vary for short periods of time. For wind-chill factors, see figure 7-2. The planner should obtain further information concerning the particular area and should allow appropriate safety factors when planning for individual clothing, winterization of equipment, etc. Temperatures in the chart are not averages,

but are the high and low extremes for each month for each place shown. The figures showing snow cover indicate expected snow depths and should not be confused with snowfall, since packing and partial melting reduce residual quantities. Mean annual precipitation includes snowfall and rain, with the total represented as inches of water (1 inch of water equals about 1 foot of snow). Generally speaking, most of the precipitation above 70° latitude is rain. This rule should be used with discretion, however, since other factors (longitude, sea currents, air currents, etc.) affect the type and quantity of precipitation.

TIME ZONE	HOURS OF DAY IN LOCAL MEAN TIME																																																											
	PREVIOUS DAY												SAME DAY																																				NEXT DAY											
	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11												
0 (Z)	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11												
-1 (A)	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12												
-2 (B)	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13												
-3 (C)	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14												
-4 (D)	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15												
-5 (E)	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16												
-6 (F)	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17												
-7 (G)	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18												
-8 (H)	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19												
-9 (I)	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20												
-10 (K)	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21												
-11 (L)	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22												
-12 (M)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23												
+1 (N)	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10												
+2 (O)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09												
+3 (P)	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08												
+4 (Q)	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07												
+5 (R)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06												
+6 (S)	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05												
+7 (T)	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04												
+8 (U)	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03												
+9 (V)	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02												
+10 (W)	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01												
+11 (X)	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00												
+12 (Y)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23												
	PREVIOUS DAY												SAME DAY																																															

Figure 7-9. Table for conversion of time throughout the world.

THE WINDCHILL FACTOR

TEMPERATURE FAHRENHEIT

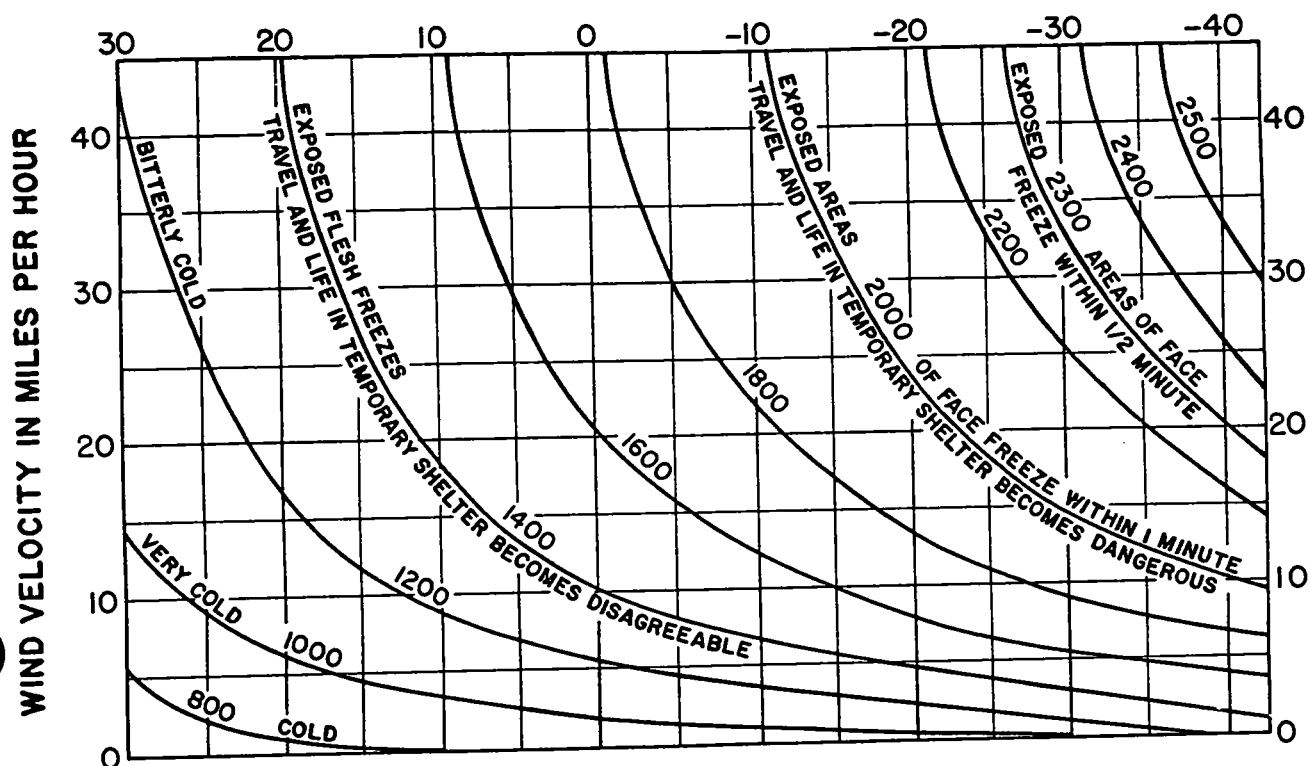


Figure 7-2. The windchill factor.

7-16. Storage Batteries

a. The electrolyte in acid-type storage batteries normally is composed of sulphuric acid and pure water. The proportion of these two substances determines the specific gravity of the electrolyte, and the specific gravity, in turn, determines the state of charge of the battery. When the battery discharges, water is formed, causing a reduction in specific gravity. When the battery charges, sulphuric acid is formed, causing an increase in specific gravity. When the ratio of acid to water is such that the specific gravity is 1.275 to 1.300 at 80° F., the battery is fully charged. The proportions of acid to water shown below are used to make electrolytes of various specific gravities at 80° F. Freezing points of the resulting electrolytes are also shown.

Parts concentrated sulphuric acid to one part of water		Specific gravity	Approximate freezing point °F.
By volume	By weight		
0.232	0.416	1.200	-16
0.250	0.545	1.210	-25
0.294	0.527	1.240	-51
0.364	0.667	1.280	-90

b. Extreme cold of arctic and subarctic areas has an adverse effect on storage batteries. At -30° F the available energy from a battery is only about 10 percent of what it would be at 80° F. For efficient operation, battery temperatures should be kept from dropping below +30° F. Normally this is accomplished through the use of winterization kits. Also, the specific gravity must be kept in the 1.275 to 1.300 range, when corrected to a temperature of +80° F. Specific gravity changes about 0.002 for each 5° temperature change below or above 80°. Specific gravities and approxi-

mate state of charge for various temperatures are given below.

Temperature °F.	Specific gravity (corrected for temperature)	Approximate state of charge (percent)
-80	1.000 (water)	Fully discharged
-80	1.130	Discharged
-75	1.213-1.238	46
-70	1.215-1.240	48
-65	1.217-1.242	50
-60	1.219-1.244	52
-55	1.221-1.246	54
-50	1.223-1.248	56
-45	1.225-1.250	58
-40	1.227-1.252	60
-35	1.229-1.254	62

Temperature °F.	Specific gravity (corrected for temperature)	Approximate state of charge (percent)
-30	1.231-1.256	63
-25	1.233-1.258	64
-20	1.235-1.260	65
-15	1.237-1.262	68
- 5	1.239-1.264	70
- 5	1.241-1.266	73
0	1.243-1.268	75
+ 5	1.245-1.270	77
+10	1.247-1.272	79
+15	1.249-1.274	80
+20	1.251-1.276	82
+25	1.253-1.278	84
+30	1.255-1.280	85
+80	1.275-1.300	100

Section V. CARGO CONTAINERS, PALLETS, AND MARKINGS

7-17. Reusable Metal Shipping Box and Container Inserts (fig. 7-3)

Figure 7-3 illustrates two reusable metal shipping boxes (cargo transporters). To facilitate handling and loading small articles, insert containers may be used with the cargo transporter. The insert container is a cardboard box with a maximum capacity of 1,000 pounds when strapped to a wooden pallet. Six insert containers fit into the standard cargo transporter (type 2) and four in the half-size (type 1). Container inserts may be used to consolidate small TOE items, thus eliminating multiple handling and much protective packaging. If units are to be moved by air, the inserts may be used as the shipping containers; cargo transporters are not necessary.

7-18. General-Purpose Pallet (fig. 7-4)

The general-purpose pallet is a four-way-entry, wooden pallet, 48 inches long, 40 inches wide, and about 5¼ inches high. It is used primarily for shipping palletized cargo. It may be loaded and shipped from shipper to consignee without the cargo being rehandled. The four-way-entry feature permits easy entrance of the forks of forklift trucks.

7-19. Sled Pallet (fig. 7-5)

The sled pallet consists of a heavy, timbered platform (4 by 6 feet) and runners (4 inches by 6 inches by 6 feet), upon which 3,000 pounds of supplies and equipment may be secured with steel bands. The pallet alone weighs 200 pounds. Cables attached to the runners permit towing. Sled pallets may be moved through any surf or over any beach which may be crossed by LVTPs, wheeled landing vehicles, or similar craft. Rations, water, fuel in 5-gallon containers, and ammunition are the most suitable supplies for pallet loading.

7-20. Shipment Marking

a. General. Address markings identify the consignee, the destination of the shipment, and other pertinent information required for shipment identification purposes. For detailed marking procedures, shipping symbols, and area designators, see MIL-STD-129D, AR 725-50, and Joint Military Standard Transportation and Movement Procedures (MIL-STAMP). Terms are defined as follows:

(1) *In-the-clear address.* A narrative description of the shipping address code.

(2) *Shipping address code.* Six-position alphanumeric code which depicts the in-the-clear address.

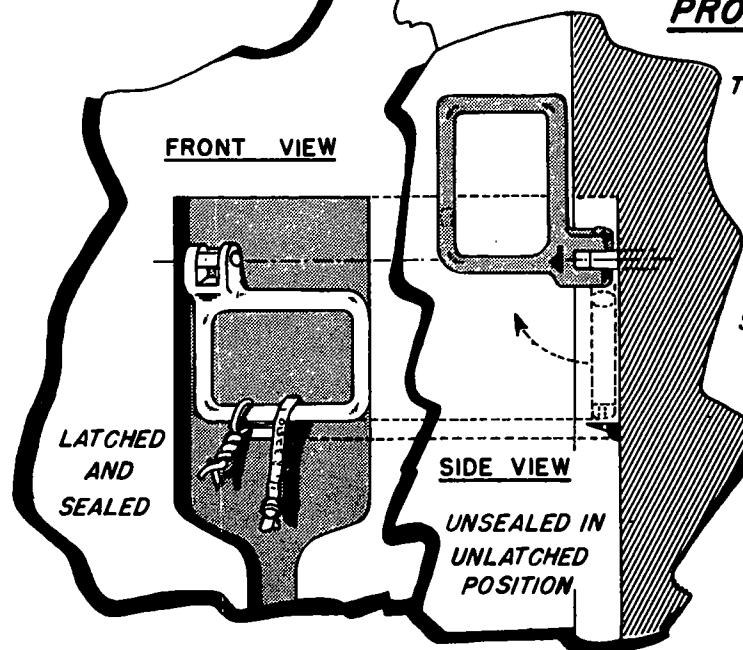
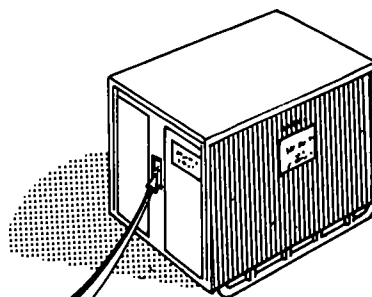
U. S. ARMY - U. S. AIR FORCE

BOX, METAL, SHIPPING, REUSABLE (CARGO TRANSPORTER)

LOADING CHARACTERISTICS

	TYPE-1 (HALF SIZE)1/	TYPE-2 (STANDARD)
<u>INSIDE</u> LENGTH	3'-10 5/8"	8'-1 5/8"
WIDTH	5'-11 3/4"	5'-11 3/4"
HEIGHT	6'-0 3/8"	6'-0 3/8"
<u>OUTSIDE</u> LENGTH	4'-3"	8'-6"
WIDTH	6'-3"	6'-3"
HEIGHT	6'-10 1/2"	6'-10 1/2"
CARGO CAPACITY	9000 LB	9000 LB
MAXIMUM TARE WT	900 LB	1500 LB
BALE CAPACITY	135 CU FT	295 CU FT
GROSS CUBE	184 CU FT	365 CU FT
GROSS M/T	4.6	9.1

1/ FOR CARGOES WITH OVERALL DENSITY IN EXCESS OF 45 POUNDS PER CUBIC FOOT.



PROPER SECURITY

THE APPLICATION OF NUMBERED SEALS ALONE DOES NOT PROVIDE ANY SECURITY AGAINST PILFERAGE.

RUPTURED SEALS ARE MERELY AN INDICATION OF A BREACH OF SECURITY.

STOUT WIRE "0" TO "3" GAGE, TIGHTLY TWISTED & SNURBED OFF CLOSELY, WILL PREVENT MOVEMENT OF THE HANDLE AND DETER THE WOULD-BE PILFERER.

LOCKS, WIRE CLOSURES, AND SEALS WILL NOT PREVENT DETERMINED, ORGANIZED THIEVERY.

Figure 7-3. Characteristics and security of cargo transporters.

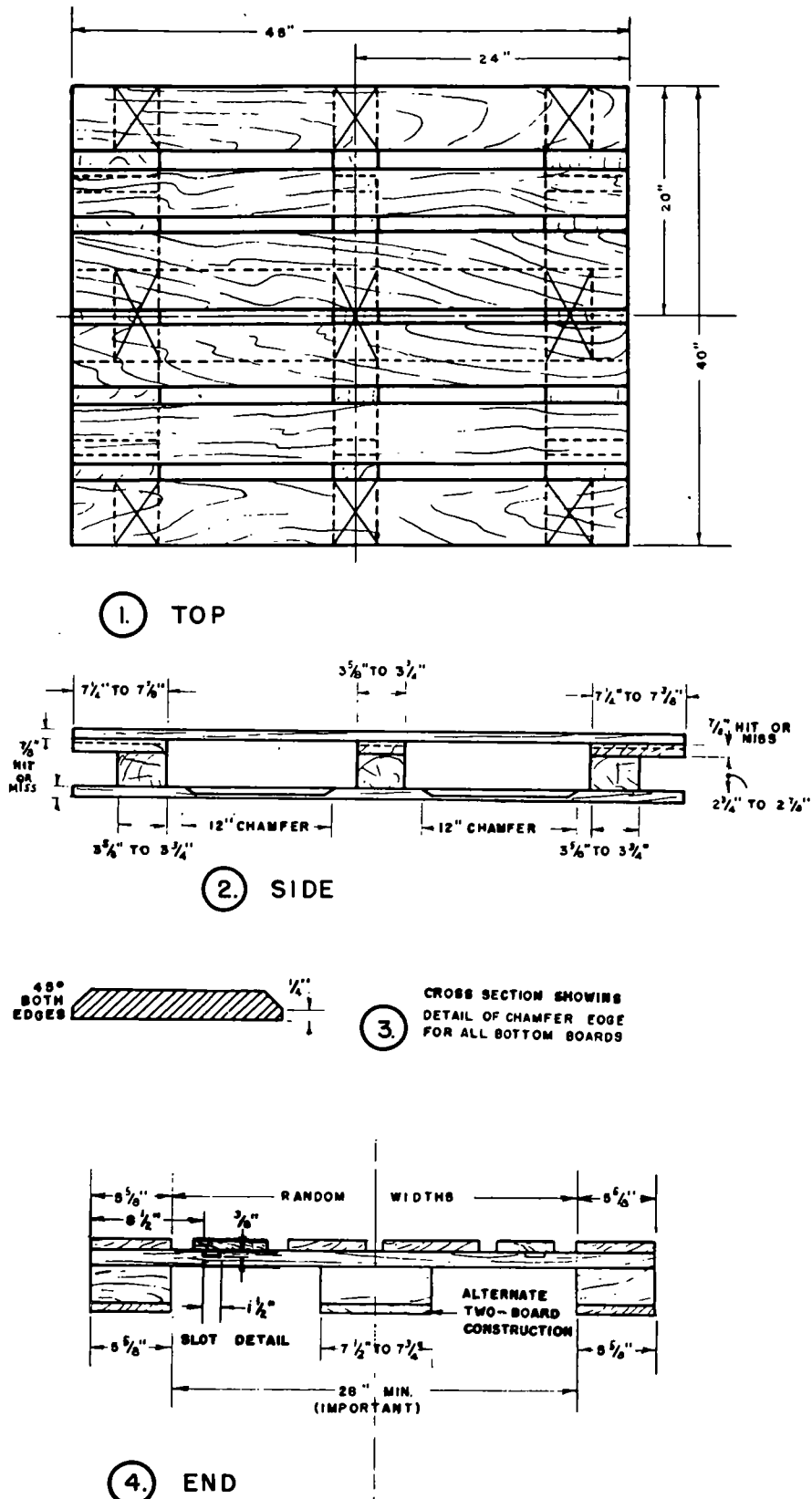


Figure 7-4. Dimensions of general-purpose pallet.

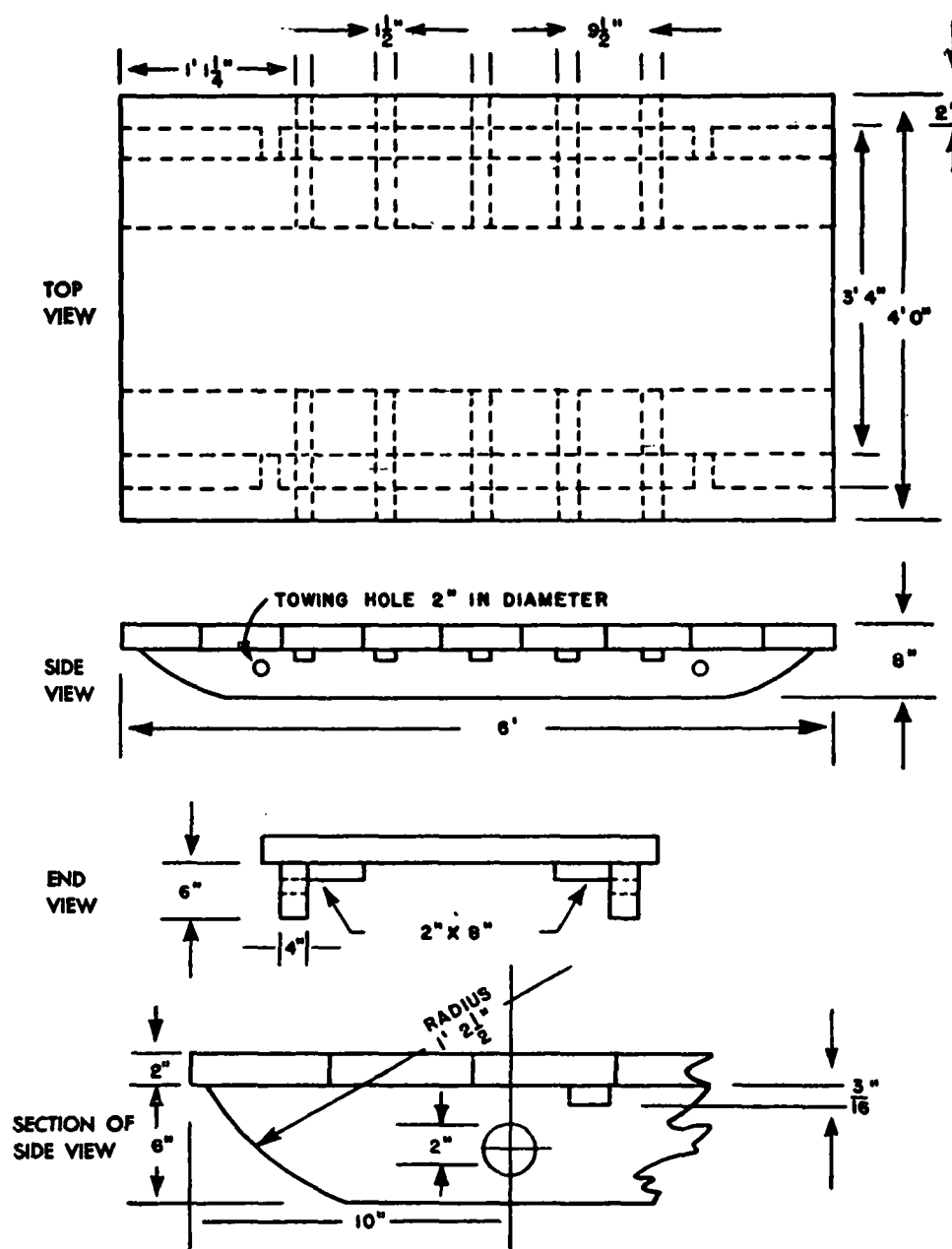


Figure 7-5. Sled pallet dimensions.

(3) *Required delivery date (RDD).* A numeric calendar date indicating when material is required by the consignee.

(4) *Port designator.* Three-position alphabetic code used to identify worldwide water ports used in the transportation of DOD material.

(5) *Project code.* Three-position alphabetic code used to identify a specific contingency plan, movement, etc.

b. *Domestic Shipment Address.* Domestic addresses shall be specified by the cognizant activity. The domestic address shall be composed as follows:

(1) *Example.*

SC 040072050169
 TP 2 213
 Rossford Ordnance Depot, Toledo,
 Ohio
 Richmond, Virginia
 1 of 4; wt: 75 lbs; cu: 8 ft

(2) *Explanation.*

Line 1. Transportation control number
 Line 2. Transportation priority number (when applicable), and required priority Julian delivery date as applicable
 Line 3. Name and address of consignor in the clear (when applicable, coded)
 Line 4. TO: Name and address of consignee in the clear (when applicable, coded)
 Line 5. Piece number, total pieces, weight and cube (this piece)

c. Oversea Address Marking. The oversea address is the most conspicuous marking on the container and is as large as available space and stencil limitations permit.

(1) *Example.*

TCN AK650062070120XXX
 RDD 280 PROV HAA TP4
 A33HRV ATLANTA ARMY DEPOT, GA.
 1MJ NORFOLK (NSC) VA.
 JK4 LAPALLICE (LAROCHELLE) FR.
 AK6500 BRACONNE ARMY DEP, BRACONNE, FRANCE
 1 of 98 WT 200 CU 40"

(2) *Explanation.*

Line 1. Transportation Control Number (TCN)

Line 2. Required delivery date 280, project code (when specified), transportation priority

Line 3. Consignor's coded and in-the-clear addresses

Line 4. Port of embarkation (coded and in-the-clear)

Line 5. Port of debarkation (coded and in-the-clear)

Line 6. Ultimate consignee's coded and in-the-clear addresses

Line 7. Piece number, total pieces, weight (this piece), cube (this piece)

d. Domestic Address. Domestic address for oversea shipments is marked as outlined in MIL-STD-129D. Composition of domestic address is as follows:

(1) FROM: (Name and address of consignor)

(2) TO: (Terminal and Address)

(3) Air movement designator when applicable

e. Dangerous Cargo. Surface shipment of ammunition, explosives, and other dangerous cargo must be packaged, marked, and labeled as required by the Department of Transportation and U.S. Coast Guard regulations. Where DA instructions conflict with those of DOT or USCG, the DOT and USCG regulations take precedence. Dangerous cargo shipped by military aircraft will be packaged, marked, and labeled as required by TM 58-250. Shipment by commercial aircraft will be in accordance with Federal Aviation Agency regulations.

f. Labels. Shippers must not use labels which by their size, shape, or color may readily be confused with the standard caution labels prescribed by the ICC.

Section VI. COMMUNICATIONS-ELECTRONICS

7-21. Joint Nomenclature Systems

a. Type Designation Systems. Two joint type designation systems have been established, the Joint Electronics Type Designation

System (MIL-STD-196) and the Joint Photographic Type designation System (MIL-STD-155). AN/ at the beginning of a term indicates that the item is electronic and an end item.

For details on the nomenclature for the components of electronic end items and for photographic equipment, whether end item or component, see BS 700-20.

b. Electronic End Items. All U.S. Army, Navy, Air Force, and Marine Corps communications-electronics end items (except photographic) may be identified using the joint nomenclature chart shown in *d* below.

c. Example. The chart describes the installation; the type of equipment; the purpose of the equipment, and the model number. For example, in the designation AN/VRC-12, AN indicates the joint system, V—ground vehicular, R—radio, C—communication (receiving and transmitting), and 12—the model number of that piece of equipment.

d. Interpretation.

AN/ System indicator	V Where it is	R What it is	C What it does	18 Model number of a specific type
INSTALLATION		TYPE OF EQUIPMENT		PURPOSE
A—Airborne (installed and operated in aircraft)	A—Invisible light, heat radiation	A—Auxiliary assemblies (not complete operating sets)		
B—Underwater mobile, submarine	B—Pigeon (inactivated, do not use)	B—Bombing		
C—Air-transportable (inactivated, do not use)	C—Carrier (wire)	C—Communications (receiving and transmitting)		
D—Pilotless carrier	D—Radiac	D—Direction finder		
F—Fixed	E—Nupac	E—Ejection and/or release		
G—Ground, general ground use (includes two or more ground installations)	F—Photographic	G—Gun or searchlight directing		
K—Amphibious	G—Telegraphic or teletype (wire)	H—Recording (photographic, meteorological, and sound)		
M—Mobile (installed as operating unit in a vehicle which has no function other than transporting the equipment)	I—Interphone and public address	L—Searchlight control (inactivated, use G)		
P—Pack or portable (animal or man)	J—Electro-mechanical or inertial wire	M—Maintenance and test assemblies (including tools)		
S—Water, surface craft	K—Telemetry	N—Navigational aids (including altimeters, beacons, depth sounding, approach and landing, compasses, radar beacons)		
T—Ground, transportable	L—Countermeasures (inactivated, do not use)	P—Reproducing (photographic and sound)		
U—General utility (includes two or more general installation classes, airborne, shipboard, and ground)	M—Meteorological	Q—Special or combination of types		
V—Ground, vehicular (installed in vehicle designed for functions other than carrying electronic equipment, etc., such as tanks)	N—Sound in air	R—Receiving		
W—Water surface and underwater	P—Radar	S—Detecting and/or range of bearing		
	Q—Sonar and under water sound	T—Transmitting		
	R—Radio	W—Remote control		
	S—Special types, magnetic, etc., or combinations of types	X—Identification and recognition		
	T—Telephone (wire)			
	V—Visual and visible light			
	W—Armament (peculiar to armament not otherwise covered)			
	X—Facsimile or television			
	Y—Data processing			

7-22. Radio Sets and Auxiliary Equipment

a. Characteristics of Selected FM Radio Sets.

Radio set	Nomenclature Rcvr	Xmtr	Freq (MHz)	Planning range (KM)*	Emission	Tuning	No. of channels	Power required	Power output (watts)**	Weight (lb) Installed in vehicle	Portable
AN/GRC 3	RT-66	RF-66	20.0-27.9	16 or 24	Voice	Continuous (2 preset)	80	12 or 24	2 or 16	276	
	RT-70	RF-70	47.0-58.4	1.6	Voice	Continuous (2 preset)	115	12 or 24	0.5	276	
	RT-108	RF-70	20.0-27.9	1.6	Voice	Continuous (2 preset)	80	12 or 24	0.5	276	
AN/PRC-6	RT-196	RT-196	47.0-55.4	1.6	Voice	1 preset	43	BA-270/U	0.25		6.5
AN/PRC-8	RT-174	RF-174	20.0-27.9	5 or 8	Voice	Continuous	80	BA-279/U	1.0		26.1
AN/PRR-9	PRR-9	RF-174	47.0-57.0	0.46 or 1.6	Voice/MCW	½ preset	201	BA-505	.001/.0045		0.45
AN/PRT-4	PRR-9	PRT-4	47.0-57.0	0.46 or 1.6	Voice/MCW	½ preset	201	2BA-399	.001/.0045		0.90
AN/PRC-25	RT-505	RT-505	30.0-75.95	5, 8 or 30	Voice	Detent	920	BA-386	1.5, 2.0 or 2.5		26
*AN/PRC-80	RT-505	RT-505	30.0-75.95	5, 8 or 30	Voice	Detent (2 presets)	920	AM4306	1.5, 2.0 or 2.5		35
AN/VRC-12	RT-246	RT-246	30.8-75.95	24 or 32	Voice	Detent (10 presets)	920	24	3 or 35	160	
AN/VRC-24	R-442 OA-2648	RT-246 OA-2648	30.0-75.95 225.0-399.9	24 or 32 Approx. 50 km w/ aircraft at 1000'	Voice Voice	Detent Continuous (20 presets)	920 1,750	24 24	1.5	160 115	
AN/VRC-43	RT-246	RT-246	30.0-75.95	24 or 32	Voice	Detent (10 presets)	920	24	3 or 35	120	
AN/VRC-44	RT-246	RT-246	30.0-75.95	24 or 32	Voice	Detent (10 presets)	920	24	3 or 35	198	
AN/VRC-45	R-442 RT-246	RT-246 RT-246	30.0-75.95 30.0-75.95	24 or 32 24 or 32	Voice Voice	Detent Detent (10 presets)	920 920	24 24	3 or 35	198 226	
AN/VRC-46	RT-524	RT-524	30.0-75.95	24 or 32	Voice	Detent	920	24	3 or 35	115	
AN/VRC-47	RT-524	RT-524	30.0-75.95	24 or 32	Voice	Detent	920	24	3 or 35	132	
	R-442	RT-524	30.0-75.95	24 or 32	Voice	Detent	920	24	3 or 35	132	
AN/VRC-48	RT-524	RT-524	30.0-75.95	24 or 32	Voice	Detent	920	24	3 or 35	191	
	R-442	RT-524	30.0-75.95	24 or 32	Voice	Detent	920	24	3 or 35	191	
AN/VRC-49	RT-524	RT-524	30.0-75.95	24 or 32	Voice	Detent	920	24	3 or 35	212	
AN/VRC-53	RT-505	RT-505	30.0-75.95	5, 8 or 30	Voice	Detent	920	24	2 or 25	69	
AN/GRC-125	RF-505	RT-505	30.0-75.95	8 or 30	Voice	Detent (2 presets)	920	BA-386 or AM4306; 24 V DC veh	25 or 2.5	81.5	26

*Based on mode of operation (mobile versus stationary).

**High and low power figures.

b. Characteristics of Selected AM Radios (Except Aircraft).

Radio set	Nomenclature Rcvr	Xmtr	Freq (MHz)	Planning range (km)	Emission	Tuning	Power required	Power output (watts)	Weight (lb)	
									Vehicle	Portable or ground
AN/GRC-9	RF-77	RF-77	2.0-12.0	16 or 24	Voice	Continuous	PE-162 (portable); GN-43 or GN-58 and BA-48 or BA-317 (ground)	Ground: 6-voice 10-CW; vehicle: 7-voice 15-CW	--	160
AN/GRC-87	RF-77	RT-77	2.0-12.0	16 or 30	MCW	Continuous	PE-162 (portable); GN-43 or GN-58 and BA-48 or BA-317 (ground)	Ground: 6-voice 10-CW	--	160
AN/VRC-34	RF-77	RT-77	2.0-12.0	32 or 48	CW	Continuous	6, 12, or 24 (vehicular)	Vehicle: 7-voice 15-CW	96	--
AN/GRC-19	R-392	T-195	0.5-32	80	Voice	Continuous	Vehicular: 28.5	100	239	--
AN/GRC-26D	R-390	T-368	1.5-20	120	CW	Continuous	115-V AC	400-voice 450-CW	--	5,600
			0.5-32 1.5-20	160	Voice MCW and CW					
AN/GRC-46	R-392	T-195	0.5-32 1.5-20	80	Voice CW	Continuous	28.5	100	--	1,050
AN/VRC-29	R-392	T-195	0.5-32 1.5-20	80	Voice CW	Continuous	28.5	100	464	--
AN/VSC-1	R-395	T-195	0.5-32	80	Voice CW	Continuous	28.5	100	419	--
AN/GRC-106	RT-662	RT-662	2-29.9	80	Voice CW	Continuous	Vehicle: 24-27.5, hps (ground); 110-220 V DC	200-voice 400-CW	--	122
AN/GRC-142	RT-662	RT-662	2-29.9	80	Voice CW and MCW	Continuous	28, 60 amp maximum	200-voice 400-CW	--	1,250
AN/VSC-2	RT-662	RT-662	2-29.9	80	Voice CW and MCW	Continuous	28, 60 amp maximum	200-voice 400-CW	--	630
AN/GRR-5	R-174	--	1.5-18	--	--	Continuous	Vehicle: 6, 12, 24; ground: 1 BA-405 and 2 BA-419 or 115 V DC 50/60 hps	--	75	75

c. Characteristics of Selected Aircraft Radios (FM and AM).

Radio set	Nomenclature Rcvr	Xmtr	Freq (MHz)	Planning range (km)	Emission	Tuning (V DC)	Power required	Power output (watts)	Weight (lb) installed in aircraft
<i>FM sets*</i>									
AN/ARC-44	RT-294	RT-294	24.0-51.9	80	Voice	Continuous	27.5, 8 amps	8	28.4
AN/ARC-54	RT-348	RT-348	30.0-69.95	46	Voice	Continuous	27.5, 7.4 amps	10	30
<i>AM sets*</i>									
AN/ARC-51	RF-702	RF-702	225-399.9	48	Voice	Continuous (monitors 243 MHz)	27.5, 10 amps	10	33.5
AN/ARC-55	RT-349	RT-349	225-399.9	48	Voice	Continuous (monitors 243 MHz)	27.5, 10 amps	9	63
AN/ARC-102	RT-698	RT-698	2.0-29.9	Line of sight voice or CW	Voice CW	Continuous	27.5 V DC, or 115 V AC, 400 hps	400	61
AN/ARC-4	RT-159	RT-159	120-130	16	Voice, MCW, CW	2 normal presets	BA-264	.035	5.8 (portable)
AN/ARC-10	RT-278	RT-278	238.0-263.0	48	Voice, CW, MCW	Fixed	16 V dry battery	0.2	3.1 (portable)

*May also be used in ground installations and ground to air.

d. Selected Radio Control and Other Auxiliary Equipment.

Radio equipment	Nomenclature Control group	Equipment used with these sets	Purpose	Planning range (km)	Weight (lb)	Power required	Other accessories required
AN/GRA-6	FM radio	AN/GRC-19 AN/PRC-8 AN/PRC-9 AN/PRC-10	Local and remote control of one or two radio sets.	3.2	21.85	4 BA-30 1 BA-414	Wire (WD-1/TT).
AN/GRA-39	FM radio	AN/PRC-25 AN/VRC-12 AN/VRC-43 thru AN/VRC-49	Remote control of one radio set.	3.2	24.375	12 BA-30	Wire (WD-2/TT).
AN/GSA-7	FM radio—wire integration.	AN/PRC-25 AN/VRC-12 AN/VRC-43 thru AN/VRC-49	Radio/wire integration or automatic relay (using 2 sets).	16	50.3	22-30 V DC (vehicular) 115 V AC or 230 V AC, 50/400 hps fixed.	When used with VRC-12 family, requires cable assembly 7474/u (fixed).
RC-282	FM radio antenna group.	Tactical FM radio sets	Stationary ground plane antenna (20-76 MHz).	2½ times normal for quarter w/whip.	48	--	--

e. Field Wire and Field Cable Data.

Type or model	Cubic feet	Weight (lb)	Short tons	Measurement tons
Wire, WD-1 ()/TT or Spool, DR-8A, 1,320 ft (402.3m) -----	0.374	14	0.007	0.0093
Wire, WD-1 ()/TT or Dispenser, MX-306/G, 2,640 ft (804.6m) ..	0.669	26	0.013	0.0167
Wire, WD-1 ()/TT or Reel, RL-159 ()/U, 1 mile (1.6 km) ----	1.50	66	0.033	0.0375
Wire, WD-1 ()/TT or Reel, DR-5, 2½ mile (4 km) -----	3.859	154	0.077	0.0964
Wire, WD-1 ()/TT alone 1 mile (1.6 km) -----	-----	48	0.240	-----
Telephone Cable Assembly, CX-4566/G (26 pr) or Reel, RC-435/U, 250 ft (76.2m) -----	2.197	68	0.340	0.0549
Telephone Cable Assembly, CX-1606/G (spiral 4) or Reel, DR-15B, 1,320 ft (402.3m) -----	3.960	137	0.0685	-----

Section VII. POL CONTAINERS AND PIPELINES

7-23. Pipeline Estimates

a. *Rate of Discharge.* The quantity of fluid passing through a pipe in a unit of time is termed the capacity or rate of discharge of the pipe and may be determined from the equation

$$Q = A \times V$$

where

Q = rate of discharge in cubic feet per second

A = cross-sectional area of the pipe in square feet

V = mean velocity of fluid in feet per second

(1) If the rate of discharge is given in terms of U.S. gallons, these may be converted to cubic feet by multiplying the given number of gallons by 0.13368. Cubic feet may be converted to U.S. gallons by multiplying the number of cubic feet by 7.4805.

(2) The cross-sectional area of the pipe in square feet is determined by using the equation

$$A = 0.7854D^2$$

where

A = cross-sectional area of the pipe in square feet

D = inside diameter of the pipe in feet

(3) The mean velocity of a fluid varies according to the size, hydraulic gradient, and physical condition of the pipe through which

it flows. Economical pipeline velocities are ordinarily in the range of 3.5 to 5.5 feet per second.

b. *Example.* Determine the rate of discharge of an 8-inch pipeline in which gasoline is flowing at a velocity of 3 miles per hour.

$$D = 8/12 \text{ or } 0.67 \text{ foot}$$

$$A = 0.7854 \times (0.67)^2 = 0.3525 \text{ square foot}$$

$$3 \text{ mph} = \frac{3 \text{ mph} \times 5,280 \text{ feet per mile}}{60 \text{ minutes per hour}} = 264 \text{ feet per minute}$$

$$264 \text{ feet per minute} \times 0.3525 \text{ square foot} = 93.1 \text{ cubic feet per minute}$$

$$93.1 \text{ cubic feet per minute} \times 7.4805 \text{ gallons per cubic foot} = 696.43 \text{ gallons per minute.}$$

c. *Increasing Capacity.* The volume of liquid which can be transported through a given pipeline may be increased by longer operation and/or increased pressure. These methods may be used individually or in combination; however, they should be used only on a short-term basis. If increased capacity is desired over a considerable period of time, it is usually better to construct an additional pipeline.

(1) *Hours of operation.* Normal capacity of a pipeline is based on an operating time of 20 hours per day.

(2) *Differential pressure.* Increasing the differential pressure of all pumping stations increases the capacity of a given pipeline. To increase the differential pressure of a pumping station, increase the differential pressure on

each pump in the pumping station and/or the number of pumps operating in series at the pumping station.

d. Capacity of Standard Military Light-weight Steel Tubing.

Inside diameter of line (in.)	Normal design capacity (bbl per hr)	Emergency capacity (bbl per hr)	Safe working pressure (psi)	Maximum working pressure (psi)	Gallons per day *	Short tons per day
4.35	355	393	600	750	294,000	930
6.415	785	1,000	600	750	630,000	2,000
8.415	1,355	1,730	500	600	1,135,000	3,500
12.481	7,150	11,400	400	530	6,000,000	18,000

*Computed for an average of all products at normal design capacity, using a 20-hour operating day.

e. Capacity of Pipes and Cylindrical Conduits. The formula below is used to determine the number of gallons per 12 inches of pipe or cylindrical conduit length. Measurements are in inches.

$$\begin{aligned} \text{Gallons per foot of length} &= \frac{(3.1416) (\text{pipe or conduit radius})^2 (12)}{231} \\ &= \frac{(9.4248) (\text{diameter})^2}{231} = (.0408) (\text{diameter})^2 \end{aligned}$$

The table in paragraph 7-28(1)(b) is applicable here if the vertical cylindrical tank is considered to be in a horizontal position, for then the gallons per foot of liquid depth in the table have the same meaning as gallons per foot of length for full pipes and cylindrical conduits on the ground. To obtain gallons per minute, multiply velocity of flow in feet per minute by the figure shown.

f. Proper Sizes for Pipes. To determine the proper diameter of a pipe for gases and liquids, use the formula in (2) below. Determine the weight of the fluid (in pounds per cubic foot) and the weight of the fluid to flow in the pipe (in thousands of pounds per hour). Then use logarithmic computations to solve the fractional powers of F and d (para 7-49). Weights indicated below are for normal atmospheric pressure (14.7 psi) and a temperature of 60°F. Variations in pressure and temperature cause the figures for gases to vary considerably, but, for the purposes of this subparagraph, changes in temperature can be disregarded. The actual pressure in the line is the principal determining factor for fluid density, since the unit of volume remains constant. Pressure changes for gases can be compen-

sated for by multiplying $\frac{P}{14.7}$ by the unit

weights shown below. In this formula, P is the actual pressure in the line.

(1) *Weights of liquids and gases.*

Fluid in pipeline	Pounds per cu ft
Liquids:	
Aviation gasoline	44.1
91A gasoline	45.7
Kerosene	50.8
Diesel oil	52.3
Lubricating oil	56.8
Water, fresh	62.4
Water, sea	64.0
Gases:	
Air	0.07658
Ammonia	0.04509
Benzene	0.20640
Butane	0.15350
Carbon dioxide	0.11637
Chlorine	0.18750
Ethylene	0.07410
Helium	0.01058
Hydrogen	0.00530
Methane	0.04234
Natural gas	0.05140
Oxygen	0.08463
Propane	0.11645
Steam	0.04761

(2) *Formula.*

$$D = 2.2 \times \frac{F^{0.45}}{d^{0.51}}$$

D = diameter of pipe in inches

F = calculated flow for the pipeline in thousands of pounds per hour.

d = density of the fluid to flow in the pipe in pounds per cubic foot

g. Data for Steel Pipe. The figures shown below can be used by the transportation plan-

ner for loading and transporting pipe and for computing volumes and weights of the fluid transported in pipes over a specified period of time. The figures in column 2 are expressed in feet so they can be squared and multiplied by 3.1416 to obtain the unit capacity shown in column 3. Inside radii in column 2 vary for the common pipe sizes, depending upon the amount of pressure the line is to carry. (A smaller diameter indicates a heavier pipe, capable of greater pressure.) To arrive at the total cubic feet per second, multiply the figures in column 3 by the actual flow in feet per second in the line. Convert to U.S. gallons per second by multiplying by 7.481, or to U.S. gallons per minute by multiplying 448.86. Pressure and, therefore, velocity can be built up to the rated capacity of the pipe and pumping system. Data in columns 4 and 5 can be used by the planner for the loading and transporting of steel pipe.

Common pipe size (in.)* 1	Actual inside radius (ft) 2	Capacity in cubic feet per second at a flow (velocity) of 1 ft per sec 3	Weight of 100 ft of pipe (lb) 4	Outside diameter of pipe (ft) 5	Common pipe size (in.)* 1	Actual inside radius (ft) 2	Capacity in cubic feet per second at a flow (velocity) of 1 ft per sec 3	Weight of 100 ft of pipe (lb) 4	Outside diameter of pipe (ft) 5	Common pipe size (in.)* 1	Actual inside radius (ft) 2	Capacity in cubic feet per second at a flow (velocity) of 1 ft per sec 3	Weight of 100 ft of pipe (lb) 4	Outside diameter of pipe (ft) 5
					3	.1097	.0379	1,502	.2915					
					3½	.1480	.0688	956.6	.333					
					3½	.1405	.0621	1,313	.333					
					4	.1680	.0886	1,134	.375					
					4	.1596	.0801	1,575	.375					
					4	.1510	.0716	1,995	.375					
					4	.1435	.0647	2,370	.375					
					5	.2102	.1390	1,544	.463					
					5	.2002	.1263	2,184	.463					
					5	.1896	.1130	2,846	.463					
					5	.1795	.1013	3,465	.463					
					6	.2524	.2000	1,995	.552					
					6	.2400	.1810	3,003	.552					
					6	.2290	.1650	3,822	.552					
					6	.2163	.1470	4,757	.552					
					8	.3390	.3605	2,352	.719					
					8	.3361	.3550	9,594	.719					
					8	.3325	.3470	3,003	.719					
					8	.3251	.3320	3,749	.719					
					8	.3180	.3178	4,557	.719					
					8	.3100	.3020	5,385	.719					
					8	.2995	.2820	6,374	.719					
					8	.2915	.2673	7,119	.719					
					8	.2832	.2525	7,844	.719					
					10	.4270	.5730	2,951	.896					
					10	.4230	.5625	3,602	.896					
					10	.4180	.5500	4,253	.896					
					10	.4060	.5170	5,754	.896					
					10	.3980	.4970	6,762	.896					
					10	.3872	.4710	8,085	.896					
					10	.3770	.4460	9,366	.896					
					10	.3650	.4185	11,025	.896					
					10	.3540	.3930	12,180	.896					
					12	.5110	.8190	3,507	1.062					
					12	.5040	.7980	4,599	1.062					
					12	.4980	.7790	5,628	1.062					
					12	.4840	.7365	7,686	1.062					
					12	.4720	.7060	9,303	1.062					
					12	.4615	.6680	11,340	1.062					
					12	.4480	.6310	13,230	1.062					
					12	.4380	.6030	14,700	1.062					
					12	.4225	.5610	16,905	1.062					
					14	.5625	.9950	3,864	1.167					
					14	.5575	.9790	4,799	1.167					
					14	.5520	.9575	5,733	1.167					
					14	.5470	.9400	6,647	1.167					
					14	.5340	.8950	8,925	1.167					
					14	.5210	.8520	11,235	1.167					
					14	.5060	.8030	13,755	1.167					
					14	.4940	.7675	15,435	1.167					
					14	.4790	.7220	17,955	1.167					
					14	.4670	.6850	20,350	1.167					
					16	.6460	1.310	4,421	1.333					
					16	.6420	1.293	5,492	1.333					
1	.01120	.000395	26.3	.0337										
1	.00896	.000243	33.6	.0337										
1	.01516	.000720	45.2	.0450										
1	.01266	.000504	56.7	.0450										
1	.02054	.001330	59.8	.0562										
1	.01760	.000974	77.7	.0562										
1	.0259	.00211	89.3	.0700										
1	.0227	.00162	114.5	.0700										
1	.0194	.00118	137.6	.0700										
1	.0344	.00372	118.7	.0875										
1	.0309	.00300	155.4	.0875										
1	.0256	.00206	203.7	.0875										
1	.0437	.00598	176.4	.1095										
1	.0398	.00497	227.9	.1095										
1	.0340	.00363	299.3	.1095										
1	.0575	.01038	239.4	.1385										
1	.0533	.00892	315.0	.1385										
1	.0483	.00733	395.9	.1385										
1	.0671	.01410	285.6	.1582										
1	.0625	.01225	382.2	.1582										
1	.0558	.00977	510.3	.1582										
2	.0862	.0233	384.3	.1980										
2	.0808	.0205	528.2	.1980										
2	.0704	.0156	782.3	.1980										
2	.1030	.0333	609.0	.2395										
2	.0967	.0294	805.4	.2395										
2	.0886	.0246	1,050	.2395										
3	.1280	.0514	795.9	.2915										
3	.1210	.0460	1,082	.2915										

For explanation of footnote see end of chart.

Common pipe Size (in.) ^a 1	Actual inside radius (ft) 2	Capacity in cubic feet per second at a flow (velocity) of 1 ft per sec 3	Weight of 100 ft of pipe (lb) 4	Outside diameter of pipe (ft) 5
16	.6350	1.265	6,573	1.333
16	.6250	1.227	8,694	1.333
16	.6120	1.176	11,340	1.333
16	.5970	1.120	14,385	1.333
16	.5810	1.058	17,325	1.333
16	.5650	1.002	20,265	1.333
16	.5470	.940	23,520	1.333
16	.5365	.902	25,305	1.333
18	.7290	1.667	4,977	1.500
18	.7240	1.648	6,695	1.500
18	.7140	1.602	8,610	1.500
18	.7025	1.550	11,025	1.500
18	.6905	1.497	13,965	1.500
18	.6725	1.420	17,955	1.500
18	.6530	1.341	21,840	1.500
18	.6380	1.280	25,095	1.500
18	.6200	1.208	28,875	1.500
18	.6035	1.145	31,920	1.500
20	.8130	2.074	5,544	1.665
20	.8025	2.025	8,253	1.665
20	.7910	1.965	11,025	1.665
20	.7835	1.931	12,915	1.665
20	.7660	1.840	17,535	1.665
20	.7480	1.757	21,945	1.665
20	.7290	1.670	26,355	1.665
20	.7080	1.573	31,385	1.665
20	.6875	1.484	35,910	1.665
20	.6725	1.420	39,270	1.665
24	.9795	3.015	6,668	2.000
24	.9680	2.945	9,944	2.000
24	.9520	2.845	14,805	2.000
24	.9440	2.803	17,955	2.000
24	.9230	2.673	24,255	2.000
24	.8990	2.532	31,185	2.000
24	.8750	2.408	37,905	2.000
24	.8540	2.290	43,680	2.000
24	.8285	2.155	50,820	2.000
24	.8080	2.052	56,280	2.000
30	1.225	4.720	10,395	2.500
30	1.207	4.575	16,590	2.500
30	1.198	4.510	20,685	2.500

^aDoes not necessarily indicate that the pipe is actually this size.

7-24. Volume of Liquid in Tanks

a. General. Transportation planners and

users frequently need weight and cube data for liquids. After a volume of liquid has been determined, the weight may be found by multiplying the total volume in gallons by the weight of 1 gallon of the liquid. (Unit weights for various liquids are to be found in para 7-23f(1)). It is assumed that the cylindrical and elliptical tanks discussed below have flat ends. (If a tank does not have flat ends, then the curvature of the ends must be determined, and the volume contained in the ends added to the volumes shown below. However, in such cases, it is usually more advantageous to calibrate the tank, which entails the drawing off or adding of measured amounts of the liquid and measuring the change in liquid depth in the tank.) In the charts below, single and/or double interpolation should be used to determine values between those shown. Values shown are close approximations for 60° F. and can be used for practical purposes. Variations in conditions, especially temperature, cause the values to vary. If exact quantities are desired, the formulas shown must be used in conjunction with temperature coefficients of expansion and contraction for the liquids and containers. Presentation of detailed computations for varying conditions is not within the scope of this manual, but approximate computations for POL products under various temperatures are shown in f below. Unless otherwise specified, dimensions are in inches.

b. Cylindrical Tanks.

(1) Vertical.

(a) *Formula.* The volume of liquid in a vertical cylindrical tank may be computed by using the formula shown below.

$$\begin{aligned}
 &\text{Gallons per foot of liquid depth} \\
 &= \frac{(3.1416) (\text{radius of tank})^2 (12)}{231} \\
 &= \frac{(9.4248) (\text{diameter of tank})^2}{231} \\
 &= (.0408) (\text{diameter})^2
 \end{aligned}$$

(b) *Table.* Gallons per foot of liquid depth are shown for vertical cylindrical tanks of various diameters.

<i>Diameter (in.)</i>	<i>Gallons per ft</i>	<i>Diameter (in.)</i>	<i>Gallons per ft</i>	<i>Diameter (in.)</i>	<i>Gallons per ft</i>
1	0.0408	54	118.9	107	467.5
2	0.163	55	123.3	108	477.5
3	0.367	56	127.9	109	486.0
4	0.653	57	132.8	110	495.0
5	1.02	58	137.4	111	503.0
6	1.47	59	142.2	112	512.5
7	2.00	60	147.1	113	522.0
8	2.61	61	152.1	114	532.5
9	3.30	62	157.0	115	541.0
10	4.08	63	162.0	116	551.0
11	4.93	64	167.5	117	560.0
12	5.87	65	172.5	118	570.0
13	6.89	66	177.7	119	580.0
14	8.00	67	183.3	120	589.0
15	9.17	68	188.3	121	597.0
16	10.44	69	194.5	122	607.0
17	11.78	70	200.0	123	617.0
18	13.22	71	206.0	124	627.0
19	14.72	72	211.9	125	637.0
20	16.31	73	217.5	126	648.0
21	18.00	74	223.6	127	658.0
22	19.75	75	229.8	128	668.0
23	21.60	76	236.0	129	679.0
24	23.50	77	242.2	130	689.0
25	25.50	78	248.7	131	698.0
26	27.56	79	255.0	132	710.0
27	29.79	80	261.2	133	722.0
28	32.00	81	268.0	134	733.0
29	34.33	82	274.8	135	743.0
30	36.65	83	281.0	136	754.0
31	39.20	84	288.0	137	766.0
32	41.80	85	295.3	138	777.0
33	44.40	86	302.0	139	788.0
34	47.20	87	309.0	140	800.1
35	49.90	88	316.8	141	811.0
36	52.80	89	323.5	142	822.0
37	55.80	90	331.0	143	833.0
38	58.90	91	338.0	144	846.0
39	62.00	92	346.0	145	858.0
40	65.30	93	353.6	146	871.0
41	68.60	94	361.0	147	882.0
42	71.90	95	369.0	148	893.0
43	75.40	96	377.0	149	906.0
44	79.00	97	384.5	150	917.0
45	82.60	98	392.5	151	930.0
46	86.30	99	401.0	152	942.0
47	90.10	100	408.5	153	955.0
48	93.90	101	417.0	154	968.0
49	97.90	102	426.0	155	979.0
50	102.0	103	434.0	156	993.0
51	106.0	104	442.5	157	1,005
52	110.1	105	451.0	158	1,018
53	114.6	106	459.0	159	1,031

<i>Diameter (in.)</i>	<i>Gallons per ft</i>	<i>Diameter (in.)</i>	<i>Gallons per ft</i>	<i>Diameter (in.)</i>	<i>Gallons per ft</i>
160	1,044	218	1,940	276	3,110
161	1,058	219	1,957	277	3,125
162	1,070	220	1,975	278	3,150
163	1,082	221	1,991	279	3,180
164	1,096	222	2,010	280	3,200
165	1,110	223	2,025	281	3,220
166	1,122	224	2,050	282	3,244
167	1,137	225	2,065	283	3,265
168	1,151	226	2,083	284	3,288
169	1,165	227	2,100	285	3,310
170	1,178	228	2,120	286	3,335
171	1,193	229	2,140	287	3,360
172	1,205	230	2,160	288	3,382
173	1,219	231	2,179	289	3,408
174	1,235	232	2,193	290	3,433
175	1,247	233	2,212	291	3,455
176	1,263	234	2,233	292	3,475
177	1,278	235	2,250	293	3,498
178	1,293	236	2,270	294	3,529
179	1,309	237	2,291	295	3,550
180	1,322	238	2,310	296	3,572
181	1,336	239	2,330	297	3,595
182	1,347	240	2,350	298	3,620
183	1,365	241	2,370	299	3,648
184	1,380	242	2,389	300	3,665
185	1,395	243	2,409	301	3,690
186	1,411	244	2,429	302	3,720
187	1,425	245	2,449	303	3,748
188	1,442	246	2,469	304	3,770
189	1,459	247	2,489	305	3,800
190	1,472	248	2,509	306	3,820
191	1,486	249	2,530	307	3,850
192	1,504	250	2,550	308	3,880
193	1,520	251	2,571	309	3,900
194	1,537	252	2,590	310	3,920
195	1,553	253	2,610	311	3,950
196	1,566	254	2,630	312	3,970
197	1,580	255	2,650	313	4,000
198	1,600	256	2,672	314	4,030
199	1,618	257	2,694	315	4,050
200	1,631	258	2,717	316	4,080
201	1,648	259	2,734	317	4,110
202	1,666	260	2,756	318	4,130
203	1,680	261	2,780	319	4,160
204	1,697	262	2,800	320	4,180
205	1,714	263	2,819	321	4,210
206	1,733	264	2,844	322	4,230
207	1,748	265	2,862	323	4,260
208	1,766	266	2,890	324	4,280
209	1,781	267	2,909	325	4,310
210	1,800	268	2,930	326	4,340
211	1,819	269	2,950	327	4,360
212	1,836	270	2,979	328	4,390
213	1,851	271	2,992	329	4,420
214	1,870	272	3,018	330	4,440
215	1,884	273	3,039	331	4,470
216	1,902	274	3,061	332	4,500
217	1,920	275	3,085	333	4,530

<i>Diameter (in.)</i>	<i>Gallons per ft</i>	<i>Diameter (in.)</i>	<i>Gallons per ft</i>	<i>Diameter (in.)</i>	<i>Gallons per ft</i>
334	4,550	455	8,450	770	24,220
335	4,580	460	8,630	780	24,870
336	4,610	465	8,830	790	25,500
337	4,630	470	9,010	800	26,120
338	4,670	475	9,200	810	26,800
339	4,690	480	9,390	820	27,480
340	4,720	485	9,600	830	28,100
341	4,740	490	9,790	840	28,800
342	4,770	495	10,000	850	29,530
343	4,800	500	10,200	860	30,200
344	4,830	505	10,400	870	30,900
345	4,860	510	10,600	880	31,680
346	4,890	515	10,810	890	32,350
347	4,920	520	11,010	900	33,100
348	4,950	525	11,240	910	33,800
349	4,980	530	11,460	920	34,600
350	4,990	535	11,670	930	35,360
351	5,030	540	11,890	940	36,100
352	5,060	545	12,100	950	36,900
353	5,080	550	12,330	960	37,700
354	5,110	555	12,560	970	38,450
355	5,150	560	12,790	980	39,250
356	5,180	565	13,090	990	40,100
357	5,210	570	13,280	1,000	40,850
358	5,240	575	13,500	1,010	41,700
359	5,270	580	13,750	1,020	42,600
360	5,280	585	13,980	1,030	43,400
365	5,440	590	14,220	1,040	44,250
370	5,580	600	14,700	1,050	45,100
375	5,740	610	15,210	1,060	45,900
380	5,890	620	15,700	1,070	46,750
385	6,060	630	16,200	1,080	47,750
390	6,200	640	16,750	1,090	48,600
395	6,370	650	17,250	1,100	49,500
400	6,530	660	17,770	1,110	50,300
405	6,700	670	18,330	1,120	51,250
410	6,860	680	18,880	1,130	52,200
415	7,030	690	19,450	1,140	53,250
420	7,190	700	20,000	1,150	54,100
425	7,380	710	20,600	1,160	55,100
430	7,540	720	21,190	1,170	56,000
435	7,730	730	21,750	1,180	57,000
440	7,900	740	22,360	1,190	58,000
445	8,080	750	22,980	1,200	58,900
450	8,260	760	23,600		

(2) *Horizontal.*

(a) When the capacity of a horizontal cylindrical tank is known, the quantity in the tank may be approximated by using the scale below.

<i>Part of tank depth filled</i>	<i>Part of tank capacity filled</i>
	1.000
0.95	.974
.90	.948
.85	.904

<i>Part of tank depth filled</i>	<i>Part of tank capacity filled</i>
.80	.860
.75	.804
.70	.740
.65	.687
.60	.626
.55	.563
.50	.500
.45	.437
.40	.374
.35	.318
.30	.252

Part of tank depth filled	Part of tank capacity filled
.25	.196
.20	.140
.15	.096
.10	.052
.05	.026

Example. A horizontal tank is 80 inches in diameter. Depth of liquid in tank is 20 inches. Full tank capacity is 8,000 gallons. Find the number of gallons actually in tank.

$$\frac{20}{80} = 0.25 \text{ (part of tank depth filled)}$$

$$0.25 \text{ (part of tank depth filled)} = 0.196 \text{ (part of tank capacity filled)}$$

$$0.196 \times 8,000 = 1,568 \text{ gallons in tank}$$

(b) When the capacity of a horizontal cylindrical tank is not known, the volume of liquid may be computed as shown below.

L = length of tank

l = depth of liquid in tank

r = radius of tank

h = distance from top of tank to surface of liquid

Tank less than half full			
l/D	Quantity to multiply D by to obtain a	l/D	Quantity to multiply D by to obtain a
.01	0.200	.26	1.070
.02	0.284	.27	1.093
.03	0.348	.28	1.115
.04	0.403	.29	1.137
.05	0.451	.30	1.159
.06	0.495	.31	1.181
.07	0.536	.32	1.203
.08	0.574	.33	1.224
.09	0.609	.34	1.245
.10	0.644	.35	1.266
.11	0.676	.36	1.287
.12	0.708	.37	1.308
.13	0.738	.38	1.328
.14	0.767	.39	1.349
.15	0.795	.40	1.369
.16	0.823	.41	1.390
.17	0.850	.42	1.410
.18	0.876	.43	1.430
.19	0.902	.44	1.451
.20	0.927	.45	1.471
.21	0.952	.46	1.491
.22	0.976	.47	1.511
.23	1.000	.48	1.531
.24	1.024	.49	1.551
.25	1.047	.50	1.571

(d) The volume of liquid in flat-end horizontal cylindrical tanks of various sizes is given below. Quantities are in U.S. gallons for each liquid depth shown per foot of tank

D = diameter of tank

a = cross-sectional length of "wet arc" formed by liquid, measured on lower part of tank

a' = cross-sectional length of "dry arc" above liquid, measured on upper part of tank

1. When tank is less than half full:

$$\text{Volume (gal.)} = \left[\frac{a^2 r}{2} - (r - 1) \sqrt{2rl - l^2} \right] \times \frac{L}{231}$$

2. When tank is half full:

$$\text{Volume (gal.)} = \frac{r^2 L}{147}$$

3. When tank is more than half full:

Volume (gal.)

$$= \left[3.1416r^2 - a'r + (r - h) \sqrt{2rh - h^2} \right] \times \frac{L}{231}$$

(c) When it is not practical to measure a and a' in the formulas above (because of buried tanks, etc.), the lengths of these arcs can be computed by determining l/D and h/D ratios, and using the table below.

Tank more than half full			
h/D	Quantity to multiply D by to obtain a'	h/D	Quantity to multiply D by to obtain a'
.01	0.200	.26	1.070
.02	0.284	.27	1.093
.03	0.348	.28	1.115
.04	0.403	.29	1.137
.05	0.451	.30	1.159
.06	0.495	.31	1.181
.07	0.536	.32	1.203
.08	0.574	.33	1.224
.09	0.609	.34	1.245
.10	0.644	.35	1.266
.11	0.676	.36	1.287
.12	0.708	.37	1.308
.13	0.738	.38	1.328
.14	0.767	.39	1.349
.15	0.795	.40	1.369
.16	0.823	.41	1.390
.17	0.850	.42	1.410
.18	0.876	.43	1.430
.19	0.902	.44	1.451
.20	0.927	.45	1.471
.21	0.952	.46	1.491
.22	0.976	.47	1.511
.23	1.000	.48	1.531
.24	1.024	.49	1.551
.25	1.047	.50	1.571

length. Therefore, in the formulas shown in (b) above, the ratio $L/231$ becomes a constant of 0.0519. To obtain liquid volume, multiply the figure from the chart by the tank length (feet and fractions).

Depth of liquid in tank (in.)

	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
9	.95	2.34	3.30																	
12	1.15	2.95	4.73	5.9																
15	1.30	3.41	5.67	7.6	9.18															
18	1.45	3.85	6.61	9.4	11.8	13.2														
21	1.58	4.24	7.37	10.5	13.5	16.0	18.0													
24	1.70	4.61	8.10	11.8	15.5	18.9	21.8	23.5												
27	1.78	4.86	8.70	12.8	17.0	21.0	24.7	27.5	29.8											
30	1.91	5.23	9.30	13.7	18.4	23.0	27.5	31.5	34.8	36.8										
33	1.99	5.43	9.80	14.5	19.6	24.8	29.8	34.5	38.7	41.9	44.4									
36	2.12	5.80	10.3	15.4	20.9	26.4	32.0	37.5	42.5	47.1	50.8	52.9								
39	2.20	5.94	10.8	16.2	22.0	28.0	34.0	40.0	45.7	51.1	55.8	59.3	62.2							
42	2.28	6.31	11.3	17.0	23.1	29.5	36.0	42.5	48.9	55.0	60.7	65.7	69.7	72.0						
45	2.35	6.43	11.8	17.7	24.1	30.9	37.8	44.8	51.7	58.4	64.8	70.7	75.9	79.6	82.7					
48	2.45	6.78	12.2	18.4	25.1	32.2	39.5	47.0	54.5	61.8	68.9	75.6	81.8	87.2	91.6	94.0				
51	2.54	6.89	12.6	19.1	26.1	33.5	41.2	49.0	57.0	64.8	72.6	80.0	86.9	93.3	98.8	102.9	106.3			
54	2.61	7.23	13.0	19.7	27.0	34.7	42.8	51.1	59.5	67.9	76.2	84.3	92.0	99.3	105.9	111.8	116.4	119.0		
57	2.68	7.43	13.4	20.3	27.9	35.9	44.1	53.0	61.8	70.7	79.5	88.2	96.6	104.6	112.1	118.9	124.8	129.2	132.8	
60	2.76	7.64	13.8	20.9	28.7	37.1	45.8	54.9	64.1	73.5	82.8	92.0	101.1	109.8	118.2	126.0	133.1	139.3	144.1	146.9
63	2.82	7.84	14.2	21.5	29.5	38.2	47.3	56.7	66.3	76.0	85.9	95.5	105.2	114.6	123.7	132.3	140.2	147.5	153.7	158.3
66	2.89	8.05	14.6	22.1	30.4	39.3	48.7	58.4	68.4	78.6	88.9	99.1	109.3	119.3	129.1	138.5	147.4	155.7	163.2	169.7
69	2.95	8.23	14.9	22.5	31.2	40.2	50.0	60.1	70.5	81.0	91.7	102.6	113.2	123.7	134.1	144.2	153.8	163.0	171.4	179.1
72	3.02	8.42	15.3	23.2	31.9	41.4	51.3	61.7	72.5	83.4	94.5	105.8	117.0	128.1	139.1	149.8	160.2	170.2	179.6	188.4
75	3.08	8.60	15.6	23.5	32.7	42.4	52.6	63.3	74.4	85.7	97.2	108.9	120.5	132.2	143.7	155.1	166.1	176.8	187.0	196.7
78	3.15	8.78	15.9	24.2	33.4	43.3	53.9	64.9	76.3	88.0	99.9	112.0	124.1	136.3	148.3	160.3	172.0	183.4	194.4	204.9
81	3.20	8.95	16.2	24.7	34.2	44.3	55.1	66.5	78.1	90.2	102.4	115.0	127.5	140.2	152.7	165.2	177.5	189.5	201.2	212.4
84	3.25	9.12	16.6	25.2	34.9	45.2	56.3	67.9	79.9	92.3	105.0	117.9	130.9	144.0	157.0	170.0	182.9	195.6	208.0	220.0
87	3.34	9.29	16.9	25.7	35.6	46.2	57.5	69.4	81.7	94.3	107.4	120.7	134.1	147.6	161.2	174.7	188.0	201.3	214.4	227.0
90	3.43	9.45	17.2	26.2	36.2	47.1	58.6	70.8	83.4	96.4	109.8	123.5	137.3	151.2	165.3	179.3	193.2	207.0	220.7	234.1
93	3.47	9.61	17.5	26.7	36.9	48.0	59.7	72.2	85.1	98.4	111.6	126.1	140.3	154.7	169.2	183.7	198.1	212.5	226.7	240.6
96	3.50	9.78	17.8	27.1	37.5	48.8	60.8	73.5	86.7	100.4	114.4	128.8	143.4	158.2	173.1	188.0	203.0	217.9	232.6	247.2
99	3.56	9.89	18.1	27.6	38.3	49.7	61.9	74.8	88.3	102.3	116.7	131.4	146.4	161.5	176.8	192.2	207.7	223.0	238.3	253.5
102	3.61	10.1	18.4	28.0	39.0	50.5	63.0	76.2	89.9	104.2	118.9	133.9	149.3	164.8	180.5	196.4	212.3	228.1	244.0	259.7
105	3.66	10.3	18.6	28.5	39.5	51.3	64.0	77.5	91.5	106.1	121.1	136.4	152.1	168.0	184.1	200.4	216.7	233.1	249.4	265.6
108	3.71	10.4	18.9	28.9	40.0	52.1	65.1	78.7	93.0	107.9	123.2	138.9	154.9	171.2	187.7	204.4	221.1	238.0	254.8	271.5
111	3.77	10.6	19.2	29.4	40.6	52.9	66.1	79.9	94.5	109.6	125.2	141.3	157.6	174.3	191.2	208.2	225.4	242.9	259.9	277.0
114	3.82	10.7	19.5	29.8	41.1	53.7	67.1	81.2	96.0	111.4	127.3	143.7	160.4	177.4	194.7	212.1	229.7	247.8	265.0	283.3
117	3.87	10.9	19.7	30.2	41.6	54.0	67.9	82.4	97.6	113.2	129.5	145.8	162.9	180.3	198.8	215.8	233.8	252.3	270.0	288.5
120	3.92	11.0	19.8	30.6	42.0	54.2	68.7	83.6	99.2	114.9	131.8	148.0	165.5	183.2	203.0	219.5	238.0	256.8	274.9	294.0

Tank diameter (in.)

Depth of liquid in tank (in.)

	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	108	111	114	117	120
9																				
12																				
15																				
18																				
21																				
24																				
27																				
30																				
33																				
36																				
39																				
42																				
45																				
48																				
51																				
54																				
57																				
60																				
63	162.2																			
66	174.8	177.7																		
69	185.6	190.4	194.6																	
72	196.3	203.1	208.5	211.5																
75	205.6	213.6	220.4	225.5	230.0															
78	214.8	224.0	232.3	239.5	245.1	248.2														
81	223.2	233.4	242.7	251.1	258.2	263.5	268.0													
84	231.6	242.7	253.1	262.7	271.3	278.8	284.6	287.9												
87	239.4	251.2	262.5	273.1	282.8	291.6	299.0	303.9	308.7											
90	247.1	259.7	271.9	283.4	294.3	304.3	313.3	321.0	327.1	330.5										
93	254.4	267.7	280.6	292.9	304.8	315.8	327.9	335.0	342.6	343.4	352.9									
96	261.6	275.6	289.3	302.5	315.2	327.2	338.5	348.9	358.2	366.2	372.5	376.0								
99	268.4	283.1	297.5	311.4	324.8	337.8	350.0	361.4	371.9	381.4	389.3	395.2	399.5							
102	275.2	290.6	305.6	320.3	334.5	348.3	361.5	374.0	385.5	396.5	406.1	414.4	420.1	424.5						
105	281.7	297.6	313.3	328.7	343.6	358.2	372.2	385.6	398.2	410.1	421.0	430.7	437.1	445.0	449.5					
108	288.2	304.7	321.0	337.0	352.7	368.0	382.9	397.2	410.8	423.7	435.9	447.0	454.0	465.5	470.0	475.9				
111	294.4	311.5	328.4	345.0	361.3	377.4	392.9	407.6	422.4	436.4	449.0	461.5	471.0	482.8	490.5	497.4	502.6			
114	300.6	318.3	335.8	353.0	369.9	386.7	402.9	418.0	434.0	449.0	462.0	476.0	488.0	500.0	511.0	519.0	526.0	531.0		
117	306.3	324.2	342.4	360.0	377.9	394.9	411.9	428.3	444.0	460.5	474.8	489.8	503.0	516.0	527.0	537.5	546.5	553.6	558.0	
120	312.0	330.0	349.0	367.0	386.0	403.0	421.0	438.5	454.0	472.0	487.5	503.5	518.0	532.0	543.0	556.0	567.0	576.2	580.0	588.0

Tank diameter (in.)

c. Rectangular Tanks. The chart below gives liquid volumes for each foot of liquid depth in rectangular tanks of various sizes. To obtain total liquid volume, multiply the figure shown by liquid depth (feet and fractions). Figures in the chart were obtained from the following formula:

$$\text{Volume (gal.)} = \frac{Lwl}{231}$$

Where

L = length of tank in inches

w = width of tank in inches

l = depth of liquid in inches

	Length of tank (in.)								
	12	15	18	21	24	27	30	33	36
12	7.48	9.35	11.23	13.10	14.95	16.85	18.70	20.58	22.46
15	9.36	11.68	14.02	16.36	18.72	21.00	23.33	25.70	28.02
18	11.23	14.02	16.83	19.65	22.44	25.25	28.05	30.90	33.66
21	13.10	16.36	19.65	22.90	26.18	29.50	32.70	36.00	39.30
24	14.95	18.72	22.44	26.18	29.97	33.70	37.40	41.20	44.80
27	16.85	21.00	25.25	29.50	33.70	37.90	42.10	46.30	50.50
30	18.70	23.33	28.05	32.70	37.40	42.10	46.80	51.50	56.10
33	20.58	25.70	30.90	36.00	41.20	46.30	51.50	56.60	61.80
36	22.46	28.02	33.66	39.30	44.80	50.50	56.10	61.80	67.30
39	24.30	30.40	36.50	42.60	48.70	54.70	60.80	66.90	72.90
42	26.19	32.70	39.24	45.80	52.30	58.90	65.50	72.00	78.50
45	28.05	35.10	42.10	49.10	56.10	63.10	70.20	77.20	84.20
48	29.93	37.40	44.90	52.30	59.80	67.30	74.80	82.30	89.80
51	31.75	39.71	47.70	55.70	63.60	71.50	79.60	87.50	95.40
54	33.70	42.10	50.50	58.80	67.30	75.70	84.10	92.60	101.00
57	35.50	44.40	53.25	62.20	71.00	80.00	88.80	97.70	106.60
60	37.40	46.75	56.10	65.40	74.80	84.10	93.50	102.90	112.20
63	39.30	49.10	58.90	68.70	78.40	88.40	98.20	108.00	117.70
66	41.10	51.40	61.70	72.00	82.30	92.50	102.80	113.30	123.40
69	43.10	53.70	64.50	75.20	85.90	96.80	107.40	118.40	129.00
72	44.90	56.10	67.30	78.50	89.70	100.90	112.20	123.50	134.60
75	46.75	58.40	70.10	81.80	93.40	105.10	117.00	128.60	140.10
78	48.60	60.75	72.90	85.10	97.20	109.30	121.60	133.70	145.90
81	50.50	63.10	75.70	88.30	100.80	113.50	126.30	139.00	151.40
84	52.40	65.50	78.60	91.60	104.60	117.60	131.00	144.00	157.10
87	54.20	67.80	81.30	94.80	108.30	122.00	135.60	149.20	162.60
90	56.10	70.20	84.20	98.20	112.20	126.10	140.30	154.50	168.30
93	58.00	72.45	86.90	101.40	115.70	130.40	145.00	159.50	174.00
96	59.80	74.80	89.80	104.50	119.60	134.50	149.60	164.50	179.50
99	61.70	77.20	92.60	108.00	123.50	138.90	154.40	169.70	185.20
102	63.60	79.60	95.50	111.20	127.20	143.00	158.90	174.50	190.70
105	65.40	81.90	98.30	114.50	131.00	147.30	163.60	179.60	196.40
108	67.30	84.20	101.20	117.80	134.60	151.50	168.30	184.90	202.00
111	69.20	86.60	103.90	121.00	138.30	155.50	173.00	190.00	205.20
114	71.00	88.90	106.70	124.40	142.10	159.80	177.70	195.00	213.20
117	72.80	91.30	109.50	127.50	145.90	164.00	182.40	200.50	219.00
120	74.75	93.60	112.40	130.80	149.60	168.20	187.00	205.30	224.40

	Length of tank (in.)								
	39	42	45	48	51	54	57	60	63
12	24.30	26.19	28.05	29.93	31.75	33.70	35.50	37.40	39.30
15	30.40	32.70	35.10	37.40	39.71	42.10	44.40	46.75	49.10
18	36.50	39.24	42.10	44.90	47.70	50.50	53.25	56.10	58.90
21	42.60	45.80	49.10	52.30	55.70	58.80	62.20	65.40	68.70
24	48.70	52.30	56.10	59.80	63.60	67.30	71.00	74.80	78.40
27	54.70	58.90	63.10	67.30	71.50	75.70	80.00	84.10	88.40
30	60.80	65.50	70.20	74.80	79.60	84.10	88.80	93.50	98.20
33	66.90	72.00	77.20	82.30	87.50	92.60	97.70	102.90	108.00
36	72.90	78.50	84.20	89.80	93.40	101.00	106.60	112.20	117.70
39	79.00	85.10	91.10	97.20	103.30	109.40	115.50	121.60	127.60
42	85.10	91.60	98.10	104.70	111.20	117.80	124.40	131.00	137.40
45	91.10	98.10	105.20	112.20	119.20	126.20	133.20	140.20	147.20
48	97.20	104.70	112.20	119.70	127.20	134.60	142.00	149.50	157.00
51	103.30	111.20	119.20	127.20	135.00	143.00	151.00	158.90	166.80
54	109.40	117.80	126.20	134.60	143.00	151.50	159.90	168.30	176.60
57	115.50	124.40	133.20	142.00	151.00	159.90	168.80	177.50	186.50
60	121.60	131.00	140.20	149.50	158.90	168.30	177.50	187.00	196.40
63	127.60	137.40	147.20	157.00	166.80	176.60	186.50	196.40	206.00
66	133.90	144.00	154.10	164.60	174.60	185.10	195.50	205.50	215.80
69	139.80	150.50	161.20	172.00	182.60	193.50	204.50	215.00	225.30
72	146.00	157.10	168.10	179.50	190.50	202.00	213.00	224.30	235.20
75	152.00	163.50	175.20	187.00	198.50	210.30	222.00	233.30	245.00
78	158.00	170.20	182.20	194.50	206.40	219.00	231.00	243.00	255.00
81	164.10	176.60	189.30	202.00	214.50	227.00	239.90	252.30	264.90
84	170.20	183.30	196.30	209.40	222.50	235.60	249.00	261.60	274.90
87	176.40	289.80	203.30	217.00	230.50	244.00	257.80	271.00	284.60
90	182.50	196.40	210.30	224.40	238.50	252.50	266.90	280.50	294.10
93	188.50	203.00	217.20	231.90	246.10	261.00	275.20	289.80	304.00
96	194.40	209.50	224.40	239.40	254.10	269.30	284.00	299.30	314.00
99	200.50	216.00	231.50	247.00	262.10	277.80	293.00	308.80	324.00
102	206.50	222.50	238.50	254.30	270.00	286.00	302.00	318.00	333.20
105	212.50	229.00	245.30	261.50	278.00	294.50	311.00	327.20	343.20
108	218.60	235.60	252.70	269.30	286.00	303.00	319.80	336.60	353.00
111	224.80	242.00	259.80	276.60	294.00	311.00	328.80	346.00	362.90
114	230.90	248.70	266.90	284.20	302.00	319.80	337.80	355.30	372.90
117	237.00	255.00	273.90	291.50	310.00	328.20	346.50	365.00	382.90
120	242.90	261.80	280.70	299.10	318.00	336.60	355.30	374.00	392.20

	Length of tank (in.)								
	66	69	72	75	78	81	84	87	90
12	41.10	43.10	44.90	46.75	48.60	50.50	52.40	54.20	56.10
15	51.40	53.75	56.10	58.40	60.75	63.10	65.50	67.80	70.20
18	61.70	64.50	67.30	70.10	72.90	75.70	78.60	81.30	84.20
21	72.00	75.20	78.50	81.80	85.10	88.30	91.60	94.80	98.20
24	82.30	85.90	89.70	93.40	97.20	100.80	104.60	108.30	112.20
27	92.50	96.80	100.90	105.10	109.30	113.50	117.60	122.00	126.10
30	102.80	107.40	112.20	117.00	121.60	126.30	131.00	135.60	140.30
33	113.30	118.40	123.50	128.60	133.70	139.00	144.00	149.20	154.50
36	123.40	129.00	134.60	140.10	145.90	151.40	157.10	162.60	168.30
39	133.90	139.80	146.00	152.00	158.00	164.10	170.20	176.40	182.50
42	144.00	150.50	157.10	163.50	170.20	176.60	183.30	189.80	196.40
45	154.10	161.20	168.10	175.20	182.20	189.30	196.30	203.30	210.30
48	164.60	172.00	179.50	187.00	194.50	202.00	209.40	217.00	224.40
51	174.60	182.60	190.50	198.50	206.40	214.50	222.50	230.50	238.50
54	185.10	193.50	202.00	210.30	219.00	227.00	235.60	244.00	252.50
57	195.50	204.50	213.00	222.00	231.00	239.90	249.00	257.80	266.90

	Length of tank (in.)								
	66	69	72	75	78	81	84	87	90
Width of tank (in.)									
60	205.50	215.00	224.30	233.30	243.00	252.30	261.60	271.00	280.50
63	215.80	225.30	235.20	245.00	255.00	264.90	274.90	284.60	294.10
66	226.30	236.80	247.00	257.00	267.40	277.90	288.00	298.00	308.60
69	236.80	247.40	258.00	269.00	279.80	290.40	301.50	312.00	322.80
72	247.00	258.00	269.30	280.40	291.60	302.90	314.20	325.00	336.50
75	257.00	269.00	280.40	292.20	303.90	315.80	327.00	339.00	350.40
78	267.40	279.80	291.60	303.90	316.00	328.00	340.30	352.80	364.70
81	277.90	290.40	302.90	315.80	328.00	341.00	353.50	366.00	379.00
84	288.00	301.50	314.20	327.00	340.30	353.50	366.50	379.90	393.00
87	298.00	312.00	325.00	339.00	352.80	366.00	379.90	393.00	406.80
90	308.60	322.80	336.50	350.40	364.70	379.00	393.00	406.80	421.00
93	319.00	333.00	347.50	362.00	377.00	391.50	406.00	421.00	435.00
96	329.00	342.10	359.00	373.90	389.00	403.50	419.00	433.50	449.00
99	339.30	355.00	370.70	385.80	401.00	416.00	432.00	447.00	462.50
102	349.60	365.80	381.40	397.00	413.20	428.50	445.00	460.70	477.00
105	360.00	376.80	392.90	408.00	425.50	442.00	458.00	474.50	491.00
108	370.30	387.20	404.00	421.00	437.80	454.00	471.10	487.00	505.00
111	380.60	398.00	415.00	432.00	449.00	467.00	484.00	501.50	519.00
114	391.00	408.00	426.40	444.00	462.00	479.00	497.50	515.00	533.00
117	401.70	419.00	437.50	456.00	474.00	492.00	510.90	528.00	547.50
120	411.50	430.70	449.00	467.00	486.00	504.90	523.00	542.00	561.00

	Length of tank (in.)								
	93	96	99	102	105	108	111	114	117
Width of tank (in.)									
12	58.00	59.80	61.70	63.60	65.40	67.30	69.20	71.00	72.80
15	72.45	74.80	77.20	79.60	81.90	84.20	86.60	88.90	91.30
18	86.90	89.80	92.60	95.50	98.30	101.20	103.90	106.70	109.50
21	101.40	104.50	108.00	111.20	114.50	117.80	121.00	124.40	127.50
24	115.70	119.60	123.50	127.20	131.00	134.60	138.30	142.10	145.90
27	130.40	134.50	138.90	143.00	147.30	151.50	155.50	159.80	164.00
30	145.00	149.60	154.40	158.90	163.60	168.30	173.00	177.70	182.40
33	159.50	164.50	169.70	174.50	179.60	184.90	190.00	195.00	200.50
36	174.00	179.50	185.20	190.70	196.40	202.00	205.20	213.20	219.00
39	188.50	194.40	200.50	206.50	212.50	218.60	224.80	230.90	237.00
42	203.00	209.50	216.00	222.50	229.00	235.60	242.00	248.70	255.00
45	217.20	224.40	231.50	238.50	245.30	252.70	259.80	266.90	273.90
48	231.90	239.40	247.00	254.30	261.50	269.30	276.60	284.20	291.50
51	246.10	254.10	262.10	270.00	278.00	286.00	294.00	302.00	310.00
54	261.00	269.30	277.80	286.00	294.50	303.00	311.00	319.80	328.20
57	275.20	284.00	293.00	302.00	311.00	319.80	328.80	337.80	346.50
60	289.80	299.30	308.80	318.00	327.20	336.60	346.00	355.30	365.00
63	304.00	314.00	324.00	333.20	343.20	353.00	362.90	372.90	382.90
66	319.00	329.00	339.30	349.60	360.00	370.30	380.60	391.00	401.70
69	333.00	342.10	355.00	365.80	376.80	387.20	398.00	408.00	419.00
72	347.50	359.00	370.70	381.40	392.90	404.00	415.00	426.40	437.50
75	362.00	373.90	385.80	397.00	408.00	421.00	432.00	444.00	456.00
78	377.00	389.30	401.00	413.20	425.50	437.80	449.00	462.00	474.00
81	391.50	403.50	416.00	428.50	442.00	454.00	467.00	479.00	492.00
84	406.00	419.00	432.00	445.00	458.00	471.10	484.00	497.50	510.90
87	421.00	433.50	447.00	460.70	474.50	487.00	501.50	515.00	528.00
90	435.00	449.00	462.50	477.00	491.00	505.00	519.00	533.00	547.50
93	449.00	463.00	478.00	492.00	507.00	521.00	536.00	550.00	564.90
96	463.00	478.80	494.00	508.70	524.00	539.00	554.00	568.50	584.00
99	478.00	493.50	509.80	525.00	540.00	556.00	571.00	587.00	602.00
102	492.00	508.70	525.00	540.90	557.00	572.00	587.50	604.00	620.00
105	507.00	524.00	540.00	557.00	572.50	589.00	605.00	622.00	638.00
108	521.00	539.00	556.00	572.00	589.00	606.00	622.50	639.90	657.00
111	536.00	554.00	571.00	587.50	605.00	622.50	639.00	657.00	674.00
114	550.00	568.50	587.00	604.00	622.00	639.90	657.00	675.80	693.00
117	564.90	584.00	602.00	620.00	638.00	657.00	674.00	693.00	712.00
120	579.00	598.00	617.00	636.00	654.00	673.00	691.00	711.00	729.90

	Length of tank (in.)						
	120	128	126	129	182	185	188
12	74.75	76.70	78.50	80.40	82.25	84.10	86.00
15	93.60	95.90	98.30	100.50	103.00	105.30	107.60
18	112.40	115.20	118.00	120.80	123.50	126.50	129.20
21	130.80	134.10	137.40	140.50	143.90	147.20	150.50
24	149.60	153.50	157.10	160.90	164.50	168.30	172.00
27	168.20	172.50	176.70	180.90	185.00	189.40	193.50
30	187.00	191.80	196.40	201.30	205.70	210.50	215.10
33	205.30	210.50	215.50	220.90	226.00	231.00	236.00
36	224.40	230.00	235.60	241.00	246.90	252.50	258.10
39	242.90	249.00	255.00	261.00	267.00	273.30	279.70
42	261.80	268.50	274.90	281.00	288.00	294.40	301.10
45	280.70	287.50	294.50	302.00	308.00	315.50	322.80
48	299.10	304.80	314.10	321.80	329.00	336.80	344.00
51	318.00	325.90	333.80	341.80	349.80	357.80	365.80
54	336.60	345.00	353.40	362.00	370.30	378.80	387.00
57	355.30	364.30	373.00	382.00	391.00	400.00	409.00
60	374.00	383.80	392.80	402.50	411.40	421.00	430.30
63	392.20	402.00	412.00	422.00	432.00	441.80	451.80
66	411.50	421.50	432.00	442.00	452.50	463.00	473.00
69	430.70	441.00	452.00	462.50	473.00	484.00	495.00
72	449.00	460.00	471.30	482.00	493.50	505.00	516.00
75	467.00	479.00	491.00	502.00	514.00	526.00	537.50
78	486.00	498.00	510.50	522.50	535.00	547.00	559.00
81	504.90	517.00	530.00	542.50	555.00	567.50	580.50
84	523.00	537.00	549.80	562.50	576.00	589.00	602.00
87	542.00	556.00	569.50	582.50	597.00	610.00	623.00
90	561.00	575.00	589.00	603.00	617.00	631.00	645.00
93	579.00	593.00	607.50	622.50	637.00	652.00	666.00
96	598.00	614.00	628.00	644.00	658.30	674.00	688.00
99	617.00	632.50	648.00	663.00	679.00	694.90	711.00
102	636.00	652.00	667.50	684.00	699.00	715.80	732.00
105	654.00	671.00	687.50	703.00	719.50	736.50	752.50
108	673.00	690.00	707.50	723.50	741.00	757.50	774.00
111	691.00	709.00	726.00	743.00	760.00	777.50	795.00
114	711.00	729.00	747.00	764.00	782.00	800.00	818.00
117	729.90	748.00	766.00	784.00	802.50	820.00	839.00
120	747.50	767.00	785.00	804.00	823.00	842.00	866.00

d. *Elliptical Tanks (Horizontal).*

(1) *Formula.* The full capacity in gallons of horizontal elliptical tanks with flat ends can be computed by the following formula.

$$\text{Volume (gal.)} = \frac{.7854abL}{231}$$

Where

a = long axis of elliptical cross-section

b = short axis of elliptical cross-section

L = length of tank

(2) *Table.* For tanks of known capacity, the partial content in gallons for varying liquid depths can be determined by using the scale below. (See b(2) above for example of use.)

Part of tank depth filled	Part of tank capac- ity filled	Part of tank depth filled	Part of tank capac- ity filled	Part of tank depth filled	Part of tank capac- ity filled
0.01	0.0020	0.05	0.0187	0.09	0.0445
0.02	0.0050	0.06	0.0245	0.10	0.0520
0.03	0.0090	0.07	0.0307	0.11	0.0598
0.04	0.0134	0.08	0.0374	0.12	0.0680

Part of tank depth filled	Part of tank capac- ity filled	Part of tank depth filled	Part of tank capac- ity filled	Part of tank depth filled	Part of tank capac- ity filled
0.13	0.0764	0.43	0.4114	0.73	0.7814
0.14	0.0850	0.44	0.4240	0.74	0.7927
0.15	0.0940	0.45	0.4366	0.75	0.8039
0.16	0.1032	0.46	0.4492	0.76	0.8150
0.17	0.1127	0.47	0.4619	0.77	0.8260
0.18	0.1224	0.48	0.4745	0.78	0.8368
0.19	0.1323	0.49	0.4873	0.79	0.8474
0.20	0.1423	0.50	0.5000	0.80	0.8577
0.21	0.1526	0.51	0.5127	0.81	0.8677
0.22	0.1632	0.52	0.5255	0.82	0.8776
0.23	0.1740	0.53	0.5381	0.83	0.8873
0.24	0.1850	0.54	0.5508	0.84	0.8968
0.25	0.1961	0.55	0.5634	0.85	0.9060
0.26	0.2073	0.56	0.5760	0.86	0.9150
0.27	0.2186	0.57	0.5886	0.87	0.9236
0.28	0.2300	0.58	0.6011	0.88	0.9320
0.29	0.2407	0.59	0.6136	0.89	0.9402
0.30	0.2531	0.60	0.6261	0.90	0.9480
0.31	0.2648	0.61	0.6386	0.91	0.9555
0.32	0.2766	0.62	0.6510	0.92	0.9626
0.33	0.2884	0.63	0.6634	0.93	0.9693
0.34	0.3003	0.64	0.6756	0.94	0.9755
0.35	0.3119	0.65	0.6881	0.95	0.9813
0.36	0.3244	0.66	0.6997	0.96	0.9866
0.37	0.3366	0.67	0.7116	0.97	0.9910
0.38	0.3490	0.68	0.7234	0.98	0.9950
0.39	0.3614	0.69	0.7352	0.99	0.9980
0.40	0.3739	0.70	0.7469	1.00	1.0000
0.41	0.3864	0.71	0.7593		
0.42	0.3989	0.72	0.7700		

e. Spherical Tanks. The chart ((4) below) may be used to determine the liquid volume in spherical tanks for various depths of the liquid. Also shown are three formulas which may be used instead of the table. When more precise computations are desired, use the formulas which do not require figures from the chart. Volumes are shown in cubic inches; cubic inches are divided by 231 to obtain gallons. In this subparagraph, the words "sphere" and "tank" have the same meaning, and the letters used represent the following:

d = depth of liquid or height of segment of sphere formed by liquid (when tank is less than half full)

= distance from top of sphere to surface of liquid (when tank is more than half full)

C = a value for different d/D relationships which represents the volume of

the sphere segment divided by the cube of the sphere's diameter

D = diameter of tank

(1) *When tank is less than half full:*

(a) To find the volume of the liquid, form the ratio d/D and find the value of C in the table. Then Volume of liquid = D^3C

(b) Alternate method: (chart not required) Volume of liquid = $.5236d^2(3D - 2d)$

(2) *When tank is half full:*

Volume of liquid = $.2618D^3$ (chart not required)

(3) *When tank is more than half full:*

(a) Since the ratio d/D (if d is considered the depth of liquid) becomes greater than 0.50, the table no longer applies. Therefore, the chart should be used to determine the volume of the unfilled portion. Subtract this from the total volume of the tank ($.5236D^3$) to obtain the volume of the filled portion. In this

case, d becomes the distance from the top of tank to the surface of liquid. To find the volume of the unfilled portion, form the ratio d/D and find the value of C in the chart. The unfilled portion is then D^3C , and the volume of the filled portion can be determined as follows:

$$\begin{aligned}\text{Volume of liquid} &= .5236D^3 - D^3C \\ &= D^3 (.5236 - C)\end{aligned}$$

(b) Alternate method: (chart not required)

$$\left[\begin{array}{l} \text{Volume of liquid} = .5236D^3 \\ - .5236d^3 (3D - 2d) \end{array} \right]$$

(4) Table.

d/D	C	d/D	C	d/D	C	d/D	C	d/D	C
0.01	0.0002	0.11	0.0176	0.21	0.0596	0.31	0.1198	0.41	0.1919
0.02	0.0006	0.12	0.0208	0.22	0.0649	0.32	0.1265	0.42	0.1995
0.03	0.0014	0.13	0.0242	0.23	0.0704	0.33	0.1334	0.43	0.2072
0.04	0.0024	0.14	0.0279	0.24	0.0760	0.34	0.1404	0.44	0.2149
0.05	0.0038	0.15	0.0318	0.25	0.0818	0.35	0.1475	0.45	0.2227
0.06	0.0054	0.16	0.0359	0.26	0.0878	0.36	0.1547	0.46	0.2305
0.07	0.0073	0.17	0.0403	0.27	0.0939	0.37	0.1620	0.47	0.2383
0.08	0.0095	0.18	0.0448	0.28	0.1002	0.38	0.1694	0.48	0.2461
0.09	0.0120	0.19	0.0495	0.29	0.1066	0.39	0.1768	0.49	0.2539
0.10	0.0147	0.20	0.0545	0.30	0.1131	0.40	0.1843	0.50	0.2618

f. Temperature Corrections (Approximate) for POL Products.

Product	Coefficient of expansion or contraction (base of 60° F.)*	Product	Coefficient of expansion or contraction (base of 60° F.)*
Aviation gasoline	0.00070	Medium crude oil (15° to 35° API gravity, and lubricating oil	0.00040
Motor gasoline and naphtha (other than cleaning solvent)	0.00060	Heavy crude oil (up to 15° API gravity), residual oil, and asphalt	0.00035
Light crude oil (above 35° API gravity), jet fuel, cleaning solvent, kerosene, distillate fuel oil, and fog oil	0.00050		

*Refers to change in unit volume per degree over or under 60° F.

7-25. Dimensions of Containers

Nomenclature	Units in package	Type of package	Length	Size of package (in.) Width or diameter	Height
Drum:					
U.S. 55-gal., 16-gage	1	Drum	0	24 1/8	34 3/4
U.S. 55-gal., 18-gage	1	Drum	0	24 5/8	34 7/8
Can:					
U.S. 5-gal. (gasoline)	1	Can	13 3/4	6 1/2	18 3/8
U.S. 5-gal. (oil)	2	Case	0	11 15/16	14 3/16
U.S. 5-qt. (oil)	6	Case	0	14	10
U.S. 1-qt. (oil)	12	Case	18	13	6
Pail:					
U.S. 25-lb (grease)	1	Pail	0	11 1/2	11 1/2

7-26. Bulk Capacities

Carrier	Gallons	Gasoline #1A (bulk)	Short tons	Lube oil (bulk)
Barge, coastwise ¹	200,000 to 400,000	45.9 to 91.8	761 to 1,522	
Barge, harbor and canal ²	15,000 to 30,000	257	57 to 114	
Barge, Navy ponton ³	84,000		320	
Pipeline: ⁴		930		
4-inch	304,000 per day	2,000	1,150	
6-inch	655,000 per day ⁵	3,500	2,500	
8-inch	1,135,000 per day	614 to 1,228	4,350	
Railroad tank car	8,000; 10,000; 12,000	24.1; 30.6; 36.8	30.4; 38.1; 45.7	
Semitrailer, 12-ton, 4W	5,000	15.3	19	
Ship, large tanker ⁶	2.5 to 11 million	7,620 to 33,500	9,480 to 43,800	
Ship, small tanker ⁷	600,000 to 2 million	1,830 to 6,140	2,280 to 7,610	
Tank, bolted-steel	10,500; 42,000; 420,000	32.2; 128; 1,280	39.9; 160; 1,600	
Tank, portable fabric ⁸	10,000	30.6	38.1	
Tank truck, F-3, fuel or oil	750	2.3	2.9	
Tank truck, L-2, oil service	600	1.8	2.3	
Trailer, fuel-servicing	600	1.8	2.3	
Transporter, liquid, rolling-wheel type (RLT), 1,000-gal T3 ⁹	1,000	3.0	3.7	
Truck, tractor and trailer, F-1	4,000	12.2	15.2	
Truck, tractor and 2 trailers, F-1A	8,000	24.4	30.4	
Truck, tractor and trailer, F-2	2,000	6.1	7.6	
Truck, tractor and 2 trailers, F-2A	4,000	12.2	15.2	

¹ Molded hulls.² Rectangular hulls.³ 6x18 ponton barge carrying three 42,000-gallon tanks loaded to two-thirds capacity.⁴ In maintaining the same volumetric pipeline capacity for gasoline and oil, more pressure is required for the heavier liquid.⁵ Based on 32,500 gallons per hour for 20 hours of operation. In an emergency it can deliver 30,000 gallons per hour for 24 hours of operation, or 720,000 gallons per day.⁶ The ship tanker most commonly used is the T2-SE-A1, a 5,922,000-gallon tanker. It is 425 feet long and draws 31 feet. It has three 8-flanged discharge outlets and four discharge pumps rated 1,000 gpm at 100 psi.⁷ Draft loaded, 12 to 20 feet.⁸ 40 feet long, 12 feet wide, 8 feet high when filled. When empty, it can be rolled to 20 inches by 12 feet; 10 can be carried in a 6x6 truck.⁹ A pair of removable synthetic-rubber containers (fuel cells) mounted on an axle and towing unit. Each cell has a capacity of 500 gallons.

Section VIII. SUPPLY

7-27. Classes of Supply

Class	Definition	How obtained
I	Articles consumed at an approximately uniform rate, such as rations.	From QM class I distributing points. Basis of issue is the daily report of personnel strength and equipment status submitted through channels.
II	Articles authorized by established allowances, such as TOE, TA, or special authorizations.	By requisition. Often submitted through channels to Army ACS Logistics.
II(A)	Aviation supplies and equipment for which allowances for initial issue to organizations are prescribed by appropriate Table of Allowance lists.	By requisition. Often submitted through channels to Army ACS Logistics.
III	Fuels, lubricants, fuel oils, coal and	Directly from Army logistical command distribution points.
III(A)	Aviation fuels and lubricants.	Obtained on credit basis or by exchange of empty for filled containers.

Class	Definition	How obtained
IV	Supplies and equipment in excess of, or not authorized by, established allowances, not in any other class, or transferred to class IV because special control measures are required.	By requisition. Submitted as for class III items. Depots normally require staff approval before issue. Critical items require authority of superior headquarters.
IV(A)	Aircraft, and aircraft equipment, parts, and supplies.	From transportation Army aircraft maintenance and supply units.
V	Ammunition, pyrotechnics, land mines, and chemicals.	Normally by credit allocations to troop units, authorizing ammunition supply points.
V(A)	Aviation ammunition, bombs, rockets, pyrotechnics, and similar expendable accessories.	Normally by credit allocations to troop units, authorizing ammunition supply points.

7-28. Shipping Data on Commonly Transported Items

a. Rations.

Type	Contents	Package or case Weight (lb)	Cu ft	Ration or packet including packaging		Avg calories per ration
				Avg weight (lb)	Avg vol (cu ft)	
Field A ¹	-----	----	----	6.0	0.183	4,200
Operational B ²	-----	----	----	6.0	0.127	4,400
Small detachment, 5 persons ³	5 rations	28.5	1.1	5.8	0.2	3,600
Combat, indiv ⁴	6 rations	38	1.2	6.5	0.2	3,600
Trail, frigid, indiv ⁵	8 rations	34	1.6	4.0	0.2	4,400
Supplement, sundries pack (1 pack per 100 men) ⁶	-----	47	1.9			
Indiv, combat, meal type	4 rations	24	----	4.8	0.85	3,600
Supplement, aid station (205 8-oz drinks) ⁷	-----	20	1.1			
Survival:						
Arctic, SA ⁸	24 packets	34	0.7	1.5	----	2,000
Tropic, ST ⁹	24 packets	36	0.7	1.5	----	1,700

¹ Basic field ration of approximately 200 items, including such perishables as fresh and frozen meats, vegetables, and fruit. For use primarily under stable conditions and during static phases of military operations when there are normal cooking and refrigeration facilities. Should be issued in preference to any other type of ration whenever circumstances permit its use. Components, weight, and volume vary.

² Canned or dry items or staple items; for use whenever mess facilities and personnel are available and no perishable foods are issued. Components, weight, and volume vary. SB 10-496 has information on its breakdown. Ration supplement, spice pack, consists of assorted spices, condiments, and leavening agents to supplement 1,000 operational rations B. The spice pack varies in weight and volume, being tailored for different situations and scaled to the B ration.

³ Nonperishable precooked food which may be eaten hot when organized messing is impossible but feeding in small groups is possible.

⁴ Nonperishable precooked food which may be eaten hot or cold, carried and prepared by the individual soldier. For use when the tactical situation is so unstable that messing in small groups is not possible and kitchen facilities are not available.

⁵ For use in extremely cold climates by small patrols or trail teams when resupply is impossible.

⁶ Comfort items such as toilet articles, tobacco, and candy as a supplement to ration B, for issue before the establishment of adequate sales facilities.

⁷ Special nourishment in the form of hot stimulating beverages for combat zone casualties at aid and clearing stations.

⁸ For survival kits aboard aircraft operating over arctic regions, in the emergency kit forming a part of the ejection seat in combat aircraft, and in emergency kits for passengers aboard transport aircraft.

⁹ Palatable food of high caloric density carried in survival kits of aircraft operating over the tropics.

b. Ammunition.

Nomenclature	Number per unit	Weight (lb)		Cubic feet		Stowage factor	
		Crated	Uncrated	Crated	Uncrated	Crated	Uncrated
Block, deml, chain	16	61.1	----	1.28	----	44	----
Block, deml, 2½ #, plastic	24	75	----	1.60	----	47	----
Canister, N2, 37mm, G	20	102	----	2.04	----	45	----
Cart, AP, cal .30, in cartons	1,500	112	----	1.5	----	30	----
Cart, AP, cal .30, 8 rd clip	1,440	112	----	1.5	----	30	----
Cart, AP, cal .50, in cartons	300	97	----	1.5	----	35	----
Cart, AP, cal .50, in cartons	360	112	----	1.5	----	30	----

Nomenclature	Number per unit	Weight (lb)		Cubic feet		Stowage factor	
		Crated	Uncrated	Crated	Uncrated	Crated	Uncrated
Cart, AP, 3", M78	4	153	----	3.22	----	47	----
Cart, AP, 7.62mm, in cartons, grade MG	1,200	86	----	1.28	----	33	----
Cart, AP, 37mm, M51	20	104	----	2.01	----	43	----
Cart, AP, 37mm, M74	20	91	----	1.01	----	50	----
Cart, AP, 75mm, M72	3	80	66	1.51	.83	28	28
Cart, AP, 90mm, M77	4	237	----	4.43	----	42	----
Cart, APC, 37mm, M59	25	99	----	2.03	----	46	----
Cart, APC, 75mm, M61	3	83	70	1.84	1.03	50	33
Cart, AP, I&T, cal .30, 1/b	1,200	101	----	1.5	----	33	----
Cart, AP, I&T, cal .50, 1/b	265	103	----	1.5	----	33	----
Cart, AP&T, cal .30, w/b	1,240	98	----	1.5	----	33	----
Cart, AP&T, cal .30, w/b	1,250	100	----	1.5	----	34	----
Cart, AP&T, cal .30, w/b	1,200	107	----	1.5	----	31	----
Cart, AP&T, cal .30, w/b (100 rds)	1,200	92	----	1.5	----	37	----
Cart, AP&T, cal .30, w/b, 250 rd mg, chest	1,000	77	----	.9	----	26	----
Cart, B&T, cal .30, w/b	1,200	93	----	1.5	----	36	----
Cart, B&T, cal .30, w/b, 250 rd mg, chest	1,000	77	----	.9	----	26	----
Cart, B&T, cal .30, web belt	1,250	96	----	1.5	----	35	----
Cart, B&T, 7.62mm, 100 rd belt	800	----	----	.91	----	----	----
Cart, B&T, 7.62mm, 210 rd belt	840	----	----	.91	----	----	----
Cart, B&T, 7.62mm, 220 rd belt	880	----	----	.92	----	----	----
Cart, ball, cal .30 carbine	3,000	100	----	.85	----	19	----
Cart, ball, cal .30 carbine	3,450	107	----	.9	----	19	----
Cart, ball, cal .30, in cartons	1,500	111	----	1.5	----	30	----
Cart, ball, cal .30, 5 rd clip	1,440	117	----	1.5	----	29	----
Cart, ball, cal .30, 5 rd clip	1,500	114	----	1.5	----	29	----
Cart, ball, cal .30, 8 rd clip	1,344	110	----	1.5	----	31	----
Cart, ball, cal .45, in cartons	1,800	97	----	.8	----	19	----
Cart, ball, cal .45, in cartons	2,000	111	----	1.0	----	20	----
Cart, ball, 7.62mm, linked, grade MG	880	78	----	.92	----	26	----
Cart, grenade, cal .30, M3	2,000	90	----	1.5	----	37	----
Cart, HE, 3"	4	153	----	3.22	----	47	----
Cart, HE, 37mm, M54	25	99	----	2.03	----	46	----
Cart, HE, 37mm, M63	20	91	----	2.04	----	50	----
Cart, HE, 37mm, Mk11	60	114	----	1.60	----	31	----
Cart, HE, 40mm, Mk1	16	115	----	1.80	----	35	----
Cart, HE, 60mm, M49A2	18	103	82	3.23	2.51	70	69
Cart, HE, 75mm, M48 w/f M48	3	80	69	1.35	.92	38	30
Cart, HE, 75mm, M48 w/f M54	3	82	68	1.84	1.03	50	34
Cart, HE, 81mm, M43A1	6	72	58	1.65	1.08	51	42
Cart, HE, 81mm, M56	3	55	42	1.33	.91	54	42
Cart, HE, 90mm, M71	4	237	----	4.43	----	42	----
Cart, HE, 105mm, M1 w/f M48	3	172	154	2.37	2.06	31	30
Cart, HE, 105mm, M54 w/f	3	172	154	2.37	2.06	31	30
Cart, inc, cal .50 in cartons	350	108	----	1.5	----	31	----
Cart, LE, 37mm, Mk1	60	105	----	1.38	----	29	----
Cart, Mk1, 75mm, wo/f	3	72	57	1.72	.96	54	38
Cart, practice, 37mm, Mk11	40	90	----	1.38	----	34	----
Cart, practice, 60mm, M50A2	18	103	82	2.23	2.51	70	69
Cart, smoke, 75mm, WP, Mk2	3	72	57	1.72	.96	54	38
Cart, smoke, 75mm, WP, M64	3	82	70	1.66	.92	45	29

Nomenclature	Number per unit	Weight (lb)		Cubic feet		Stowage factor	
		Crated	Uncrated	Crated	Uncrated	Crated	Uncrated
Cart, smoke, 81mm, WP, M57 ----	3	55	45	1.65	.91	67	45
Cart, smoke, 105mm, WP, M60 ----	3	172	159	2.37	2.06	31	29
Cart, tracer, cal .50, in cartons ----	350	111	----	1.5	----	30	----
Cart, tracer, 7.62mm, M62 in car- tons, grade R ----	400	28	----	.54	----	43	----
Cart, tracer, 7.62mm, M62 in car- tons, grade R ----	960	72	----	.91	----	28	----
Cart, tracer, 7.62mm, M62 in car- tons, grade R ----	1,040	78	----	1.28	----	37	----
Cart, 12-ga, No. 00 buckshot --	500	62	----	.768	----	28	----
Cart, 12-ga, No. 7½ ----	500	58	----	.768	----	30	----
Chg, prop, M1A1 (green bag) 155H ----	6	67	40	3.08	1.91	103	107
Chg, prop, M3 (green bag) 155H --	6	82	53	3.33	2.68	91	114
Chg, prop, M2 (white bag) 155H --	6	82	73	3.26	2.63	89	81
Explosive, cratering, 40 lb ----	1	51	----	1.21	----	53	----
Explosive, TNT 1# B1 ----	50	67.7	----	1.11	----	37	----
Fuze, det, M6A2 ----	200	64	----	2.50	----	88	----
Fuze, ing, M10A2 ----	200	64	----	2.7	----	95	----
Fuze, PD, M46 ----	50	51	----	.89	----	39	----
Fuze, PD, M47 ----	50	53	----	.89	----	38	----
Fuze, PD, M51, M51A1, M55, M55A1 ----	25	83	----	1.46	----	39	----
Fuze, PD, MT, M67 ----	25	78	----	1.46	----	42	----
Grenade, AT, M11A1, prct ----	50	87	----	3.3	----	85	----
Grenade, hand, frg, Mk II ----	25	50	----	1.26	----	57	----
Grenade, hand, off (unfused) ----	50	50	----	1.37	----	62	----
Grenade, hand, tug, Mk, 1A1 ----	24	47	----	.97	----	46	----
Grenade, rifle, M9 and M9A1 ----	10	32	----	1.2	----	83	----
Grenade, rifle, prct, M11 ----	50	108	----	2.8	----	58	----
Mine, AP, blast, M25 ----	96	30	----	----	----	----	----
Mine, AP, fragmentation, M16A1 --	4	44.8	----	.77	----	35	----
Mine, AP, sharpnel, directional, M18A1 ----	6	53	----	1.74	----	74	----
Mine, AT, blast, metallic, hv, M15 --	1	49	----	1.17	----	54	----
Mine, AT, blast, nonmetallic, plastic, M19 ----	2	71.8	----	1.57	----	49	----
Mine, AT, shaped charge, metallic, M21 ----	4	90.8	----	4.14	----	94	----
Primer, DTE, M14, 1-sec delay ----	100	67	----	1.01	----	34	----
Primer, perc, Mk11, Mk11A, Mk11A1 ----	2,400	96	----	1.56	----	36	----
Projectile, 8", How ----	1	---	200	---	----	---	----
Projectile, 155mm, AP, M112B1 ----	1	117	----	1.34	----	26	----
Projecile, 155mm, all other ----	1	---	96	---	.83	--	19
Signal, illumination, ground M17 to M22 ----	61	---	----	1.85	----	--	----
Signal, pistol, rocket, Mk2, red & green star ----	103	---	----	2.57	----	--	----
Signal, pistol, rocket, Mk2 red & white ----	31	---	----	.92	----	--	----

c. Petroleum Products.

	Container	No. per unit	Weight (lb)	Cubic feet	Storage factor
Aviation gasoline ----	55-gal. drum, 18-gage steel -----	1	373	9.03	54
	55-gal. drum, 16-gage steel -----	1	389	8.8	51
	55-gal. drum, 18-gage light steel -----	1	364	9.2	56.5
	5-gal. can, 11-lb can -----	1	40.5	.81	44.8
83 octane gasoline ---	55-gal. drum, 18-gage steel -----	1	384	9.03	52.7
	55-gal. drum, 16-gage steel -----	1	400	8.8	49.2
	55-gal. drum, 18-gage light steel -----	1	376	9.2	55
	5-gal. can, 11-lb can -----	1	41.6	.81	43.6
Kerosene -----	55-gal. drum, 18-gage steel -----	1	421	9.03	48.1
	55-gal. drum, 16-gage steel -----	1	437	8.8	45.1
	55-gal. drum, 18-gage light steel -----	1	351	9.2	58.8
	5-gal. can, 11-lb can -----	1	45	.81	40.4
Diesel fuel -----	55-gal. drum, 18-gage steel -----	1	432	9.03	47
	55-gal. drum, 16-gage steel -----	1	448	8.8	44.2
	55-gal. drum, 18-gage light steel -----	1	430	9.2	47.9
	5-gal. can, 11-lb can -----	1	46	.81	39.5
Lubricating oils ----	55-gal. drum, 18-gage steel -----	1	472	9.03	42.8
	55-gal. drum, 16-gage steel -----	1	488	8.8	40.5
	55-gal. drum, 18-gage light steel -----	1	462	9.2	44.6
	5-gal. can, 11-lb can -----	1	49	.81	37.1
	Cases of 1-qt. cans, 12 per case (crated) -----	12	35	.88	56.6
	Cases of 1-qt. cans, 24 per case (crated) -----	24	60	1.6	60
	Cases of 5-qt cans, 6 per case (crated) -----	6	77	1.9	55.7
Grease -----	25-lb pails -----	1	29	.95	73.6
	5-lb cans, 6 per case (crated) -----	6	44	1.1	56

7-29. Annealed Wire

Gage No.	Diameter (in.)	Tensile strength (lb)
7	3/16	1,100
8	11/64	950
9	5/32	800
11	1/8	500

7-30. Rods and Bolts

Diameter (in.)	Tensile strength* (lb)
1/2	5,200
5/8	8,100
3/4	11,700
1	21,100
1 1/8	25,800
1 1/4	32,800
1 3/8	38,600
1 1/2	46,900

*At root of thread.

7-31. Common Nails

Type	Length (in.)
8-penny -----	2 1/2
9-penny -----	2 3/4
10-penny -----	3
12-penny -----	3 1/4
16-penny -----	3 1/2
20-penny -----	4
30-penny -----	4 1/2
40-penny -----	5
50-penny -----	5 1/2
60-penny -----	6

7-32. High-Tension Bands

Width and thickness (in.)	Tensile strength (lb)
3/8 x 0.050 -----	2,000
3/4 x 0.028 -----	2,000
3/4 x 0.030 -----	2,000
3/4 x 0.035 -----	2,500
3/4 x 0.037 -----	2,500
3/4 x 0.050 -----	3,500
1 1/4 x 0.035 -----	4,000
1 1/4 x 0.037 -----	4,000
1 1/4 x 0.050 -----	6,000
2 x 0.050 -----	9,500

Note: The use of secondhand or reclaimed high-tension wire, or common wires for such items specified in the rules and detailed figures is prohibited. (Rules and figures are those contained in AAR open top car loading manual cited in paragraph 4-14.)

7-33. Supply-Planning Terms

a. Consumption Rate. The average quantity of an item consumed or expended during a given time interval, expressed in quantities per applicable basis.

b. Day of Supply. That quantity of supplies estimated to be required for 1 day under the conditions of the operation and for the force stated.

c. Replacement Factor. A number expressed as a decimal which, when multiplied by the total projected quantity of an item in use, gives the quantity of that item required to be re-

placed during a given period of time.

d. Slice. An average logistical planning factor used to obtain estimates of requirements for personnel and materiel.

Section IX. STORAGE AND MAINTENANCE SPACE

7-34. Storage

a. Gross Storage Area: Average Ratio of Open to Covered by Classes of Supply.

	Ratios of gross storage area	
	Open	Covered
All classes (except bulk POL) ----	5.5	1
Classes I, II, III (packaged and solid), and IV -----	4.7	1
Classes I, II, III (packaged), and IV -----	3	1
Class V (including 10 percent of V-A -----	12	1

b. Average Stack Height. Figures given are for use of all services in theaters of operation. For CONUS storage, the figures must be increased 25 percent.

(1) Covered storage—8 feet (2.4 meters).

(2) Open storage—6 feet (1.8 meters).

c. Miscellaneous Data.

Ammunition storage per mile (1.6 km) of road ¹ -----	1,000 short tons
Ammunition storage per square mile ¹ -----	5,000 short tons

Minimum hardstand for 2,500 vehicles ² -----	110,000 square feet
Solid footing for vehicle park for 2,500 vehicles -----	4,000,000 sq ft
Minimum hardstand for artillery and combat vehicles, per item --	350 square feet

7-35. Covered Shop Floor Space

	Sq m	Sq ft
Maintenance and Supply:		
Direct support company -----	1,858	20,000
Guided missile depot support shop -----	1,208	13,000
Guided missile direct support shop -----	1,208	13,000
Guided missile heavy support shop -----	1,208	13,000
Tire repair company -----	1,486	16,000
Transportation:		
Heavy truck company -----	474	5,100
Light truck company -----	344	3,700
Medium truck company -----	520	5,600
Railway operating battalion ----	2,601	28,000
Railway shop battalion -----	3,716	40,000

¹ Refers to temporary storage of ammunition along roadways and in urban fields and forests, such as may be found in combat zones.

² Data based on the assumption that hardstand area will not be required for the total number of vehicles at any one time.



Section X. FIELD ESTABLISHMENTS AND EXPEDIENTS

7-36. Tentage

Type	Shape of floor	Floor dimensions (in.)	Total ground perimeter (in.)	Size				Number ^a men accommodated	Weight (lb)		Total weight (lb)
				Height Ridge (in.)	Side wall (in.)	Surface area (sq ft)	Floor space (sq ft)		Tent only	Pins, poles	
Tents:											
Arctic, 10-man--	Hexagon	210 dia	630 ^c	102	36	316	199	10	68	8	76
Assembly -----	Rectangu- lar plus rounded ends	480 x 960	2,467	252	96	4,965	2,857	80	1,100	655	1,755
Balloon inflation.	Rectangle	159 x 182	682	148	(*)	885	201	8	110	333	443
CP, M1942 -----	Rectangle	84 x 142	452	84	72	328	84	2	112	104	216
CP, M1945 -----	Octagon	120 x 247 ^f	627	108	66	406	172 ^f	3	165	92	257
Fly, squad -----	Rectangle	240 x 451	1,382	144	63	1,673	750	15	190	62	252
Fly, ward, hosp.	Rectangle	240 x 648	1,776	144	63	2,216	1,080	27	225	101	326
GP, large -----	Rectangle	216 x 624	1,680	144	66	2,035	936	21	420	245	665 ^b
GP, medium ----	Rectangle	192 x 396	1,176	120	66	915	528	12	255	200	455 ^j
Hexagonal, M1950.	Hexagon	159 dia	477	102	24	218	113	5	40	8	48
Hospital, sectional.	Rectangle	216 x 636 ^k	1,704	144	72	2,170	954 ^k	24 ^l	770	327	1,097
Hospital, ward--	Rectangle	192 x 600	1,584	144	54	2,162	800	20 ^l	390	259	649
Kitchen -----	Rectangle	144 x 216	720	144 ^m	72	831	216	10	203	217	420
Maint, shelter --	Rectangle	218 x 322	1,080	164	66	1,306	487	11	500	755	1,255
Mountain -----	Rectangle	54 x 82	272	43	12	112	31	2	6	4	10
Oper, surgical --	Rectangle	192 x 324	1,032	144	84	1,190	432	10	252	75	327
Oper, surgical, hv.	Rectangle	216 x 648	1,728	133	72	2,068	972	22	817	876	1,693
Pyramidal -----	Square	192 x 192	768	144	63	896	256	6	130	94	224
Pyramidal, lightweight.	Circle	132 dia	414	102	24	182	95	4	37	2	39
Squad, M1942 --	Rectangle	192 x 384	1,152	144	54	886	512	12	255	147	402
Squad, M1945 --	Rectangle	192 x 384	1,152	144	54	886	512	12	275	150	425
Storage -----	Rectangle	214 x 241	910	156	63	1,008	358	8	200	202	402
Wall, large -----	Rectangle	168 x 174	684	132	54	570	203	8	130	145	275
Wall, small ----	Rectangle	106 x 110	432	102	45	284	81	2	55	60	115
Paulins: ^r											
Fly, storage ---	-----	300 x 245	---	---	--	512	---	--	85	20	105
Fly, wall, small.	-----	186 x 110	---	---	--	142	---	--	23	15	38
Large -----	-----	240 x 480	---	---	--	800	---	--	250	---	250
Medium -----	-----	192 x 384	---	---	--	512	---	--	160	---	160
Screen, latrine --	(*)	216 x 108 x 84 ⁿ	660	---	72 ^t	292	144	(^u)	32	---	32
Small -----	-----	144 x 204	---	---	--	204	---	--	57	---	57

^a If used as a field billet.^b Average for normal conditions.^c Six equal sides of 105 inches each.^d Tent also ventilated by lifting sidewalls.^e Arched top.^f The two measurements shown are the longest dimensions, including vestibule (trapezoid measuring 120" x 48" x 89.5" x 89.5").^g Liner does not cover vestibule.^h Liner weighs additional 155 pounds.ⁱ Includes tent, liner, pins, and poles.^j Liner weighs additional 90 pounds and occupies a stored cubage of 8 cubic feet.

c. Cubic Measure.

Cubic centimeters	Cubic decimeters or liters	Cubic inches	Cubic feet ¹	Cubic yards	U.S. quarts		U.S. gallons		U.S. bushels	Measurement tons
					Liquid	Dry	Liquid	Dry		
1.0	0.001	0.061	0.0000353	0.0000013	0.001056	0.000908	0.000264	0.000227	0.000028	0.00000088
1,000.0	1.0	61.023	.0353	.00131	1.0567	.9081	.2642	.227	.0284	.000882
16.39	.01639	1.0	.0005787	.0000214	.0173	.0149	.00433	.00372	.00465	.0000144
28,317.0	28.317	1,728.0	1.0	.03704	29.922	25.714	7.481	6.4285	.80356	.025
764,559.0	764.559	46,656.0	27.0	1.0	807.896	694.279	201.974	173.57	21.696	.677
946.0	.9464	57.75	.03342	.00124	1.0	.8594	.25	.2148	.02686	.000837
1,101.2	1.1012	67.201	.03889	.00144	1.1636	1.0	.2909	.25	.0313	.000975
3,785.4	3.7854	231.0	.13368	.00495	4.0	3.4377	1.0	.8594	.1074	.00335
4,404.9	4.4049	268.803	.15556	.00576	4.6546	4.0	1.1636	1.0	.125	.00388
35,239.3	35.2393	2,150.42	1.2445	.0461	37.237	32.0	9.3092	8.0	1.0	.0312
1,130,000.0	1,130.0	69,120.0	40.0	1.48	1,190.0	1,030.0	298.0	256.0	32.2	1.0

¹ A board foot, used in measurements for lumber, measures 12" x 12" x 1". Its volume is 1/12 of a cubic foot.

d. Angular Conversions.

Circle	Radians	Degrees	Minutes	Seconds	Mils	Right angle	Straight line
1.0	6.2832	360.0	21,600.0	1,296,000	6,400.0	4.0	2.0
.16	1.0	57.3	3,430.0	206,000	1,018.6	.636	.318
.00279	.017453	1.0	60.0	3,600	17.778	.0111	.00556
.0000463	.000289	.0167	1.0	60	.297	.000185	.0000925
.00000078	.0000049	.00028	.0167	1	.00495	.0000003	.00000016
.000157	.000982	.05625	3.375	202	1.0	.000625	.000312
.25	1.535	90.0	5,400.0	324,000	1,600.0	1.0	.5
.50	3.07	180.0	10,800.0	648,000	3,200.0	2.0	1.0

e. Power.

Kilogram-meters per sec	Foot-pounds per sec	Horsepower		Ponclelets	Kilowatts	Watts	Thermal units per sec	
		U.S.	Metric				Btu's	Kilocalories
1.0	7.233	0.01315	0.01333	0.01	0.00981	9.80597	0.009296	0.002342
.13826	1.0	.001818	.001843	.001383	.001356	1.35573	.001285	.0003237
76.0404	550.0	1.0	1.01387	.7604	.74565	745.65	.70865	.17812
75.0	542.475	.98632	1.0	.75	.73545	735.448	.69718	.17569
100.0	723.3	1.31509	1.33333	1.0	.9806	980.597	.92957	.23425
101.979	737.612	1.3411	1.35972	1.0198	1.0	1,000.0	.94796	.23888
.10198	.73761	.001341	.001360	.00102	.001	1.0	.000948	.0002389
107.577	778.104	1.41474	1.43436	1.07577	1.0549	1,054.9	1.0	.252
426.9	3,087.77	5.61412	5.692	4.269	4.1862	4,186.17	3.9683	1.0

f. Weight.

<i>Kilograms (kg)</i>	<i>Grains (gr)</i>	<i>Troy</i>	<i>Ounces Avoirdupois (avdp)</i>	<i>Troy</i>	<i>Pounds Avoirdupois (avdp)</i>	<i>Short (2,000 lb)</i>	<i>Tons Long (2,240 lb)</i>	<i>Metric (1,000 kg)</i>
1.0	15,432.4	32.1507	35.274	2.67923	2.20462	0.001102	0.0009842	0.001
.0000648	1.0	.002083	.00012286	.0001736	.0001429	.00000007	.00000006	.00000006
.0311	480.0	1.0	1.09714	.08333	.06857	.00003429	.00003061	.0000311
.02385	437.5	.91146	1.0	.07595	.0625	.00003125	.0000279	.00002835
.37324	5,760.0	12.0	13.1657	1.0	.82286	.0004114	.0003674	.0003732
.45359	7,000.0	14.5833	16.0	1.21528	1.0	.0005	.0004464	.004536
907.185	14,000,000.0	29,166.7	32,000.0	2,430.56	2,000.0	1.0	.89286	.90719
1,016.05	15,680,000.0	32,666.7	35,840.0	2,722.22	2,240.0	1.12	1.0	1.01605
1,000.0	15,432,356.0	32,150.7	35,274.0	2,679.23	2,204.62	1.10232	.98421	1.0

Miscellaneous weight relationships:

<i>Avoirdupois</i>	<i>Troy</i>
1 ounce = 16 drams	1 carat = 0.2 gram = 3.086 grains
1 stone = 14 pounds	1 pennyweight = 1.555 grams = 24 grains
1 dram = 1.772 grams	1 ounce = 20 pennyweights

<i>Apothecaries</i>
1 scruple = 20 grains
1 ounce = 8 drams
1 dram = 3 scruples

<i>Weight system comparisons:</i>	<i>Grain</i>	<i>Ounce</i>	<i>Pound</i>
Avoirdupois	1	437.5 grains	7,000 grains
Troy	1	480 grains	5,760 grains
Apothecaries	1	480 grains	5,760 grains

Storage bulk (cu ft)			Material	Doors		Ventilation		Stove- pipe or heater open- ings	Liner	Pitching ^b		Striking ^b	
Tent only	Pins, poles	Total cubs packed (cu ft)		No.	Height (in.)	No. of open- ings	No. of win- dows			No.	Time (min)	No.	Time (min)
7.1	0.2	7.3	9 oz OD cotton	2	60	4	0	1	Yes	6	27	6	15
23.3	16.9	40.2	9.8 and 12.3 oz duck	4	96	4	0 ^d	4	No	9	90	9	60
---	---	61.4	9.8 oz duck	2	148	1	4	1	No	4	30	4	20
5.0	3.7	8.7	12.3 oz duck	1	72	1	3	1	Yes	4	20	4	15
6.3	3.6	9.9	12.3 oz duck	1	72	1	3	1	Yes ^e	5	20	5	15
4.3	5.0	9.3	9 oz duck										
7.6	4.5	12.1	9 oz duck										
21.0	7.7	69.0 ^f	12.3 oz duck	2	72	2	8	3	Yes	6	75	6	50
12.7	6.3	19.0 ^f	12.3 oz duck	2	72	2	6	2	Yes	4	40	4	30
3.6	0.2	3.8	9 oz plied yarn and sateen cotton cloth	1	60	2	0	1	Yes	5	15	5	10
31.5	12.2	43.7	12.3 oz duck except floor (9.8 oz duck)	2	72	2	16	3	Yes	9	90	9	70
20.5	9.6	30.1	12.3 oz duck	2	54	2	14	3	Yes	9	90	9	70
14.2	12.0	26.2	12.3 oz duck	1	72	Ventilator Screens ^a		0	No	5	60	5	45
26.3	58.0	84.3	12.3, 9.8 and 6 oz duck	2	164	2 ^o	0	4	No	10	75	10	60
0.5	0.2	0.7	Lightweight cotton and synthetic fiber	2	27 dia (^p)	2	0	0	No	2	10	2	5
10.3	3.5	13.8	9.8 and 12.3 oz duck	2	84	2	8	2	Yes	4	40	4	30
38.8	23.2	62.0	9.8 and 12.3 oz duck	2	72	2	16	3	Yes	9	90	9	70
6.2	3.6	9.8	12.3 oz duck	1	63	1	0	1	No	5	20	5	15
2.5	0.2	2.7	12.3 oz duck	1	---	2	0	1	No	5	15	5	10
10.9	5.9	16.8	9.8 and 12.3 oz duck	2	54	2	---	2	No	4	40	4	30
11.1	6.1	17.2	12.3 oz duck	2	54	2	---	2	Yes	4	40	4	30
9.6	9.2	18.8	12.3 oz duck	2	63	2	---	---	---	4	40	4	30
5.8	3.1	8.9	12.3 and 9.8 oz cotton duck	2	132	2	0	(^q)	No	4	30	4	20
3.4	4.1	7.5	12.3 and 9.8 oz cotton duck	2	102	2	0	(^q)	No	4	30	4	20
2.8	0.8	3.6	9.8 oz duck										
3.1	0.7	3.8	9.8 oz duck										
6.7	---	6.7	9.8 oz duck										
4.2	---	4.2	9.8 oz duck										
0.8	---	0.8	9.7 oz duck	1	---	---	---	---	No	6	20	6	15
2.3	---	2.3	9.8 oz duck										

* Does not include vestibules at each end, which measure 48" x 90".

^f Bed patients on cots.

^m Height shown is for stack section. Service section is 108 inches high.

ⁿ Ventilator screens on all sides of the service and stack sections, to be used as required.

^o Plus one large opening (120" x 120") in roof.

^p Tubular tunnel entrance, 24 inches long.

^q Either of the ventilator openings may be used as stovepipe opening.

^r Dimensions shown for flys and paulins are length and width.

^s Screen has a 3-foot overlap on one side for an entrance.

^t Bottom edge of screen normally 9 inches off ground.

^u One for average company-size unit.

Section XI. CONVERSION FACTORS

7-37. Conversion Factors

a. Linear Measure.

[U.S. dry measure: 1 bushel = 4 pecks = 8 gallons = 32 quarts = 64 pints
U.S. liquid measure: 1 gallon = 4 quarts = 8 pints = 32 gills = 128 fluid ounces = .83268 imperial gallon]

Meters*	Inches	Feet	Yards	Rods	Chains	Statute	Miles	Nautical**	Kilometers	Cables' length	Fathoms
1.0	39.37	3.28083	1.09361	0.19884	0.04971	0.0006214		0.0005396	0.001	0.00454	0.546
.0254	1.0	.0833	.0278	.00505	.00126	.00001578		.00001371	.0000254	.000116	.0139
.3048	12.0	1.0	.3333	.0606	.0151	.0001894		.0001645	.0003048	.00139	.167
.9144	36.0	3.0	1.0	.1818	.04545	.0005682		.0004934	.0009144	.00417	.500
5.0292	198.0	16.5	5.5	1.0	.25	.003125		.002714	.005029	.0228	2.76
20.1168	792.0	66.0	22.0	4.0	1.0	.0125		.01085	.02012	.091	11.0
1,609.35	63,360.0	5,280.0	1,760.0	320.0	80.0	1.0		.8684	1.6094	7.32	879.0
1,853.25	72,962.5	6,080.2	2,026.73	368.497	92.1243	1.15155		1.0	1.85325	8.46	1,010.0
1,000.0	39,370.0	3,280.83	1,093.61	198.838	49.7096	.6214		.5396	1.0	4.56	546.0
219.5	8,640.0	720.0	240.0	43.6	10.9	.1364		.1184	.2195	1.0	120.0
1.829	72.0	6.0	2.0	.363	.091	.00114		.00098	.00183	.00835	1.0

*1 meter = 10 decimeters = 100 centimeters = 1,000 millimeters.

**A nautical mile is the length on the earth's surface of an arc subtended by one minute of angle at the center of the earth. Therefore, the circumference of the earth is equivalent in nautical miles to the number of minutes in a circle (360 x 60 = 21,600).

b. Surface Measure.

Square meters	Square inches	Square feet	Square yards	Square rods	Acres	Hectares	Square miles (statute)	Square kilometers
1.0	1,550.0	10.764	1.196	0.03954	0.000247	0.0001	0.000000386	0.000001
.00065	1.0	.0069	.00077	.00000026	.00000016	.000000065	.0000000025	.0000000065
.0929	144.0	1.0	.1111	.00367	.00002296	.00000929	.0000000359	.0000000929
.8361	1,296.0	9.0	1.0	.0331	.0002066	.0000836	.000000323	.000000836
25.293	39,204.0	272.25	30.25	1.0	.00625	.000253	.00000977	.0000253
4,046.8	6,272,640.0	43,560.0	4,840.0	160.0	1.0	.4047	.00156	.00405
10,000.0	15,499,969.0	107,639.0	11,960.0	395.37	2.471	1.0	.00386	.01
2,589,999.0	Sq ft x 144	27,878,400.0	3,097,600.0	102,400.0	640.0	259.0	1.0	2.59
1,000,000.0	Sq ft x 144	10,763,867.0	1,195,985.0	39,537.0	247.1	100.0	.3861	1.0

g. Speed.

Meters per second	Meters per minute	Feet per second	Feet per minute	Miles per hour	Knots per hour	Kilo- meters per hour
1.0	60.0	3.28083	196.8	2.23693	1.94254	3.6
.0167	1.0	.055	3.3	.0376	.0324	.06
.30480	18.2	1.0	60.0	.68182	.59209	1.09728
.00505	.303	.0167	1.0	.0113	.0097	.0182
.44704	26.9	1.4667	88.0	1.0	.86839	1.60935
.51479	30.9	1.68894	101.0	1.15155	1.0	1.85325
.27778	16.7	.91134	54.7	.62137	.53959	1.0

h. Temperature. The chart below shows relationships between fahrenheit and centigrade readings for a temperature range covering most areas of the earth. Figures shown are close approximations that should cover the needs of the transportation planner or operator. To compute temperature conversions out-

side of the range shown, use one of the following formulas:

$$^{\circ}\text{C} = \frac{9}{5} (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{F} = \frac{5}{9} (^{\circ}\text{C} + 32)$$

$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$
-66	-54.4	-40	-40.0	-14	-25.6	12	-11.1	38	3.3	64	17.8	90	32.2	116	46.6
-65	-53.9	-39	-39.4	-13	-25.0	13	-10.6	39	3.9	65	18.3	91	32.8	117	47.2
-64	-53.3	-38	-38.9	-12	-24.4	14	-10.0	40	4.4	66	18.9	92	33.3	118	47.8
-63	-52.7	-37	-38.3	-11	-23.9	15	-9.4	41	5.0	67	19.4	93	33.9	119	48.3
-62	-52.2	-36	-37.8	-10	-23.3	16	-8.9	42	5.6	68	20.0	94	34.4	120	48.9
-61	-51.6	-35	-37.2	-9	-22.8	17	-8.3	43	6.1	69	20.6	95	35.0	121	49.4
-60	-51.1	-34	-36.7	-8	-22.2	18	-7.8	44	6.7	70	21.1	96	35.6	122	50.0
-59	-50.6	-33	-36.1	-7	-21.7	19	-7.2	45	7.2	71	21.7	97	36.1	123	50.6
-58	-50.0	-32	-35.6	-6	-21.1	20	-6.7	46	7.8	72	22.2	98	36.7	124	51.1
-57	-49.4	-31	-35.0	-5	-20.6	21	-6.1	47	8.3	73	22.8	99	37.2	125	51.7
-56	-48.9	-30	-34.4	-4	-20.0	22	-5.6	48	8.9	74	23.3	100	37.8	126	52.2
-55	-48.3	-29	-33.9	-3	-19.5	23	-5.0	49	9.4	75	23.9	101	38.3	127	52.7
-54	-47.8	-28	-33.3	-2	-18.9	24	-4.4	50	10.0	76	24.4	102	38.9	128	53.3
-53	-47.2	-27	-32.8	-1	-18.3	25	-3.9	51	10.6	77	25.0	103	39.4	129	53.9
-52	-46.6	-26	-32.2	0	-17.8	26	-3.3	52	11.1	78	25.6	104	40.0	130	54.4
-51	-46.1	-25	-31.7	1	-17.2	27	-2.8	53	11.7	79	26.1	105	40.6		
-50	-45.6	-24	-31.1	2	-16.7	28	-2.2	54	12.2	80	26.7	106	41.1		
-49	-45.0	-23	-30.6	3	-16.1	29	-1.7	55	12.8	81	27.2	107	41.6		
-48	-44.4	-22	-30.0	4	-15.6	30	-1.1	56	13.3	82	27.8	108	42.2		
-47	-43.9	-21	-29.4	5	-15.0	31	-0.6	57	13.9	83	28.3	109	42.7		
-46	-43.3	-20	-28.9	6	-14.4	32	0	58	14.4	84	28.9	110	43.3		
-45	-42.8	-19	-28.3	7	-13.9	33	0.6	59	15.0	85	29.4	111	43.9		
-44	-42.2	-18	-27.8	8	-13.3	34	1.1	60	15.6	86	30.0	112	44.4		
-43	-41.6	-17	-27.2	9	-12.8	35	1.7	61	16.1	87	30.6	113	45.0		
-42	-41.1	-16	-26.7	10	-12.2	36	2.2	62	16.7	88	31.1	114	45.6		
-41	-40.6	-15	-26.1	11	-11.7	37	2.8	63	17.2	89	31.7	115	46.1		

i. Simplified Conversion Factors for Quick Computation. The following are accurate to within 2 percent:

- Inches to centimeters—Multiply by 10 and divide by 4.
- Yards to meters —Multiply by 9 and divide by 10.
- Miles to kilometers —Multiply by 8 and divide by 5.
- Gallons to liters —Multiply by 4 and subtract 1/5 of the number of gallons.
- Pounds to kilograms —Multiply by 5 and divide by 11.

j. Pressure and Density Equivalents.

Kilograms per sq cm (metric atmos- pheres)	Pressure equivalents					Density equivalents				
	Pounds per sq in.	Short tons per sq ft	Atmos- pheres	Columns of mercury (0° C at sea level)		Grams per cu cm	Lb per cu in.	Lb per cu ft	Short tons per cu yd	Lb per U.S. gal.
				Meters	Inches					
	14.22	1.024	0.9678	0.7356	28.96	1	0.03613	62.43	0.8428	8.345
0.07031	1	0.072	0.06805	0.5171	2.036	27.68	1	1,728	23.33	231
0.9765	13.89	1	0.9451	0.7183	28.28	0.01602	0.000578	1	0.0135	0.1337
1.0332	14.70	1.058	1	0.76	29.92	1.187	0.04287	74.07	1	9.902
1.3595	19.34	1.392	1.316	1	39.37	0.1198	0.004329	7.481	0.1010	1
0.03453	0.4912	0.03536	0.03342	0.02540	1					

k. Equivalents . . . or Masses per Unit Lengths. The chart shown below may be used for wires, pipes, rails, etc.

Grams per centimeter	Kilograms per kilometer	Kilograms per meter	Grains per inch	Pounds per foot	Pounds per yard	Pounds per mile
1.0	100.0	0.1	39.1983	0.067197	0.201591	354.80
0.01	1.0	0.001	0.391983	0.00067197	0.000201591	3.5480
10.0	1,000.0	1.0	391.983	0.67197	2.01591	3,548.00
0.025511	2.5511	0.0025511	1.0	0.00171429	0.00514286	9.0514
14.8816	1,488.16	1.48815	583.333	1.0	3.0	5,280.0
4.96054	496.054	0.49605	194.444	0.33333	1.0	1,760.0
0.0028185	0.28185	0.00028185	0.11048	0.00018939	0.00056818	1.0

l. Simplified Conversion Factors (Feet and Inches). The chart below serves as a rapid means of converting inches to feet and inches and vice versa. Inches are shown in the extreme left column and in the spaces immediately above the three sets of double horizontal lines. In the body of the chart, feet and/or feet

and inches are shown (a dash separates feet from inches). For example, to convert 197 inches to feet and inches, find the number below the figure 190 on the top horizontal line and opposite the figure 7. It is 16-5, which represents 16 feet and 5 inches.



INCHES

	10	20	30	40	50	60	70	80	90	100	110	120
0		1-8	2-6	3-4	4-2	5	5-10	6-8	7-6	8-4	9-2	10
1		1-9	2-7	3-5	4-3	5-1	5-11	6-9	7-7	8-5	9-3	10-1
2	1-0	1-10	2-8	3-6	4-4	5-2	6	6-10	7-8	8-6	9-4	10-2
3	1-1	1-11	2-9	3-7	4-5	5-3	6-1	6-11	7-9	8-7	9-5	10-3
4	1-2	2	2-10	3-8	4-6	5-4	6-2	7	7-10	8-8	9-6	10-4
5	1-3	2-1	2-11	3-9	4-7	5-5	6-3	7-1	7-11	8-9	9-7	10-5
6	1-4	2-2	3	3-10	4-8	5-6	6-4	7-2	8	8-10	9-8	10-6
7	1-5	2-3	3-1	3-11	4-9	5-7	6-5	7-3	8-1	8-11	9-9	10-7
8	1-6	2-4	3-2	4	4-10	5-8	6-6	7-4	8-2	9	9-10	10-8
9	1-7	2-5	3-3	4-1	4-11	5-9	6-7	7-5	8-3	9-1	9-11	10-9
	260	270	280	290	300	310	320	330	340	350	360	370
0	21-8	22-6	23-4	24-2	25	25-10	26-8	27-6	28-4	29-2	30	30-10
1	21-9	22-7	23-5	24-3	25-1	25-11	26-9	27-7	28-5	29-3	30-1	30-11
2	21-10	22-8	23-6	24-4	25-2	26	26-10	27-8	28-6	29-4	30-2	31
3	21-11	22-9	23-7	24-5	25-3	26-1	26-11	27-9	28-7	29-5	30-3	31-1
4	22	22-10	23-8	24-6	25-4	26-2	27	27-10	28-8	29-6	30-4	31-2
5	22-1	22-11	23-9	24-7	25-5	26-3	27-1	27-11	28-9	29-7	30-5	31-3
6	22-2	23	23-10	24-8	25-6	26-4	27-2	28	28-10	29-8	30-6	31-4
7	22-3	23-1	23-11	24-9	25-7	26-5	27-3	28-1	28-11	29-9	30-7	31-5
8	22-4	23-2	24	24-10	25-8	26-6	27-4	28-2	29	29-10	30-8	31-6
9	22-5	23-3	24-1	24-11	25-9	26-7	27-5	28-3	29-1	29-11	30-9	31-7
	510	520	530	540	550	560	570	580	590	600	610	620
0	42-6	43-4	44-2	45	45-10	46-8	47-6	48-4	49-2	50	50-10	51-8
1	42-7	43-5	44-3	45-1	45-11	46-9	47-7	48-5	49-3	50-1	50-11	51-9
2	42-8	43-6	44-4	45-2	46	46-10	47-8	48-6	49-4	50-2	51	51-10
3	42-9	43-7	44-5	45-3	46-1	46-11	47-9	48-7	49-5	50-3	51-1	51-11
4	42-10	43-8	44-6	45-4	46-2	47	47-10	48-8	49-6	50-4	51-2	52
5	42-11	43-9	44-7	45-5	46-3	47-1	47-11	48-9	49-7	50-5	51-3	52-1
6	43	43-10	44-8	45-6	46-4	47-2	48	48-10	49-8	50-6	51-4	52-2
7	43-1	43-11	44-9	45-7	46-5	47-3	48-1	48-11	49-9	50-7	51-5	52-3
8	43-2	44	44-10	45-8	46-6	47-4	48-2	49	49-10	50-8	51-6	52-4
9	43-3	44-1	44-11	45-9	46-7	47-5	48-3	49-1	49-11	50-9	51-7	52-5

130	140	150	160	170	180	190	200	210	220	230	240	250
10-10	11-8	12-6	13-4	14-2	15	15-10	16-8	17-6	18-4	19-2	20	20-10
10-11	11-9	12-7	13-5	14-3	15-1	15-11	16-9	17-7	18-5	19-3	20-1	20-11
11	11-10	12-8	13-6	14-4	15-2	16	16-10	17-8	18-6	19-4	20-2	21
11-1	11-11	12-9	13-7	14-5	15-3	16-1	16-11	17-9	18-7	19-5	20-3	21-1
11-2	12	12-10	13-8	14-6	15-4	16-2	17	17-10	18-8	19-6	20-4	21-2
11-3	12-1	12-11	13-9	14-7	15-5	16-3	17-1	17-11	18-9	19-7	20-5	21-3
11-4	12-2	13	13-10	14-8	15-6	16-4	17-2	18	18-10	19-8	20-6	21-4
11-5	12-3	13-1	13-11	14-9	15-7	16-5	17-3	18-1	18-11	19-9	20-7	21-5
11-6	12-4	13-2	14	14-10	15-8	16-6	17-4	18-2	19	19-10	20-8	21-6
11-7	12-5	13-3	14-1	14-11	15-9	16-7	17-5	18-3	19-1	19-11	20-9	21-7
330	390	400	410	420	430	440	450	460	470	480	490	500
31-8	32-6	33-4	34-2	35	35-10	36-8	37-6	38-4	39-2	40	40-10	41-8
31-9	32-7	33-5	34-3	35-1	35-11	36-9	37-7	38-5	39-3	40-1	40-11	41-9
31-10	32-8	33-6	34-4	35-2	36	36-10	37-8	38-6	39-4	40-2	41	41-10
31-11	32-9	33-7	34-5	35-3	36-1	36-11	37-9	38-7	39-5	40-3	41-1	41-11
32	32-10	33-8	34-6	35-4	36-2	37	37-10	38-8	39-6	40-4	41-2	42
32-1	32-11	33-9	34-7	35-5	36-3	37-1	37-11	38-9	39-7	40-5	41-3	42-1
32-2	33	33-10	34-8	35-6	36-4	37-2	38	38-10	39-8	40-6	41-4	42-2
32-3	33-1	33-11	34-9	35-7	36-5	37-3	38-1	38-11	39-9	40-7	41-5	42-3
32-4	33-2	34	34-10	35-8	36-6	37-4	38-2	39	39-10	40-8	41-6	42-4
32-5	33-3	34-1	34-11	35-9	36-7	37-5	38-3	39-1	39-11	40-9	41-7	42-5
630	640	650	660	670	680	690	700	710	720	730	740	750
52-6	53-4	54-2	55	55-10	56-8	57-6	58-4	59-2	60	60-10	61-8	62-6
52-7	53-5	54-3	55-1	55-11	56-9	57-7	58-5	59-3	60-1	60-11	61-9	62-7
52-8	53-6	54-4	55-2	56	56-10	57-8	58-6	59-4	60-2	61	61-10	62-8
52-9	53-7	54-5	55-3	56-1	56-11	57-9	58-7	59-5	60-3	61-1	61-11	62-9
52-10	53-8	54-6	55-4	56-2	57	57-10	58-8	59-6	60-4	61-2	62	62-10
52-11	53-9	54-7	55-5	56-3	57-1	57-11	58-9	59-7	60-5	61-3	62-1	62-11
53	53-10	54-8	55-6	56-4	57-2	58	58-10	59-8	60-6	61-4	62-2	63
53-1	53-11	54-9	55-7	56-5	57-3	58-1	58-11	59-9	60-7	61-5	62-3	63-1
53-2	54	54-10	55-8	56-6	57-4	58-2	59	59-10	60-8	61-6	62-4	63-2
53-3	54-1	54-11	55-9	56-7	57-5	58-3	59-1	59-11	60-9	61-7	62-5	63-3

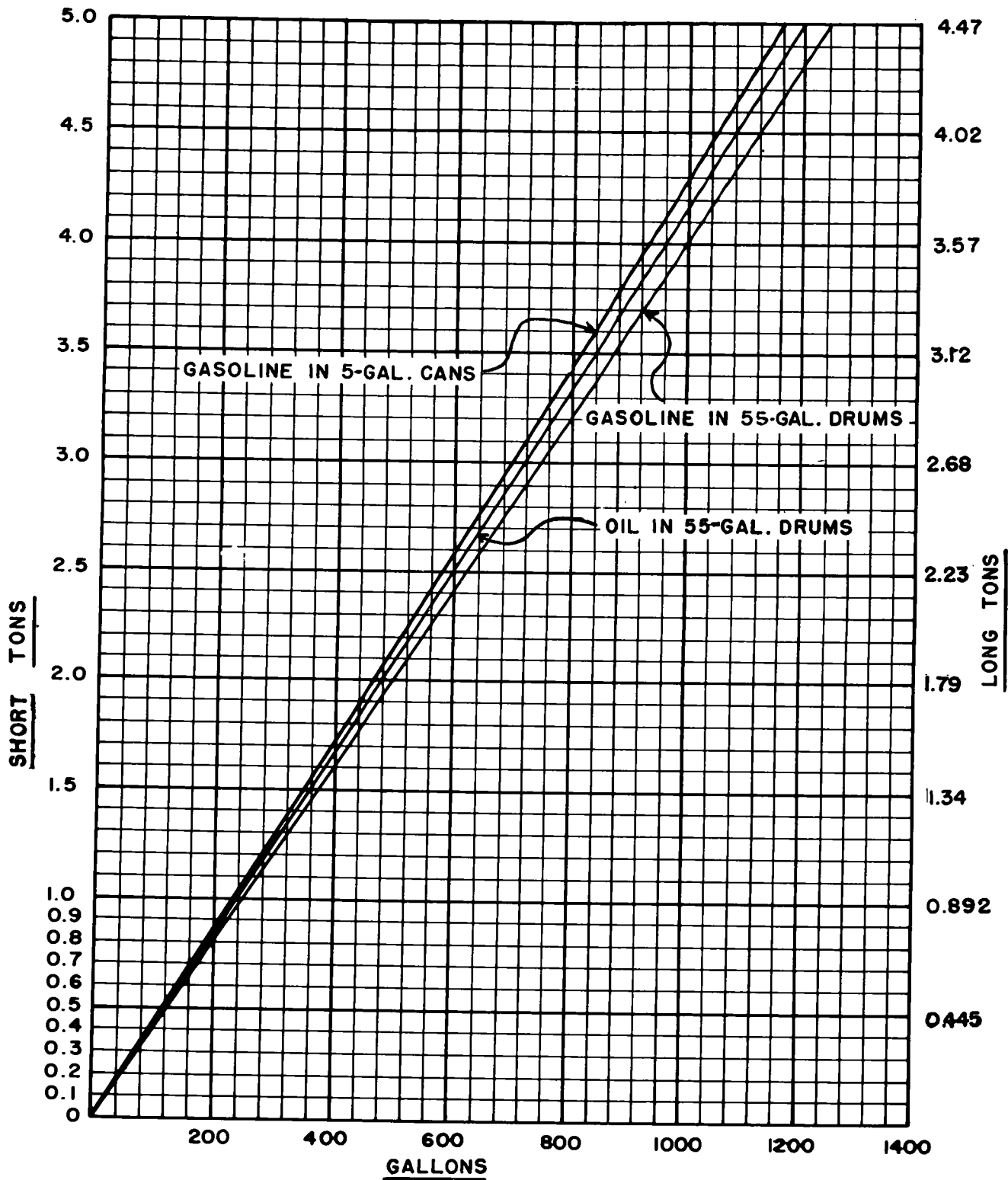


Figure 7-6. Scale for converting gallons of fuel and lubricants to tons.

7-38. Conversion of Fuel and Lubricants From Gallons to Tons

The scale in figure 7-16 is approximate and

should be used only for rapid computation. For this reason, weights given per unit of volume are slightly heavier than average.

7-39. Petroleum Conversion Factors

(Conversion factors give average, not exact figures.)

<i>Multiply</i>	<i>By</i>	<i>To obtain</i>
Gallons, gasoline	0.0027	Long tons.
Gallons, gasoline	.0026	Metric tons.
Gallons, gasoline	6.103	Pounds.
Gallons, gasoline	.0031	Short tons.
Gallons, oil	7.434	Pounds.
Long tons	367.21	Gallons, gasoline.
Measurement tons	1.086	Short tons, gasoline.
Measurement tons	1.4285	Short tons, gasoline in drums.
Measurement tons	1.0	Short tons, grease.
Measurement tons	1.11	Short tons, oil.
Measurement tons	1.2048	Short tons, oil in drums.
Metric tons	373.10	Gallons, gasoline.
Pounds	.1639	Gallons, gasoline.
Pounds	.1345	Gallons, oil.
Short tons	327.8	Gallons, gasoline.
Short tons, gasoline	.9195	Measurement tons.
Short tons, gasoline in drums	.7	Measurement tons.
Short tons, grease	1.0	Measurement tons.
Short tons, oil	.90	Measurement tons.
Short tons, oil in drums	.83	Measurement tons.

7-40. Map-Distance Conversion

a. Table.

Map distance	Ground distance	Representative fraction (RF)							
		$\frac{1}{25,000}$	$\frac{1}{50,000}$	$\frac{1}{75,000}$	$\frac{1}{100,000}$	$\frac{1}{200,000}$	$\frac{1}{250,000}$	$\frac{1}{500,000}$	$\frac{1}{1,000,000}$
One inch -----	Inches -----	25,000	50,000	75,000	100,000	200,000	250,000	500,000	1,000,000
	Feet -----	2,083	4,167	6,250	8,333	16,667	20,833	41,667	83,333
	Yards -----	694	1,389	2,083	2,778	5,555	6,944	13,888	27,776
	Kilometers -----	.635	1.27	1.91	2.54	5.08	6.35	12.7	25.4
	Miles -----	.393	.790	1.19	1.58	3.15	3.94	7.9	15.76
	Meters -----	635	1,270	1,910	2,540	5,080	6,350	12,700	25,400
One centimeter -----	Inches -----	9,843	19,685	29,528	39,370	78,740	98,425	196,850	393,700
	Feet -----	820	1,640	2,460	3,281	6,562	8,202	16,404	32,808
	Yards -----	273	547	820	1,094	2,187	2,734	5,468	10,936
	Kilometers -----	.250	.500	.750	1.0	2.0	2.5	5.0	10.0
	Miles -----	.154	.31	.465	.62	1.24	1.55	3.1	6.2
	Meters -----	250	500	750	1,000	2,000	2,500	5,000	10,000

b. Examples of use.

(1) A map distance of 1 inch is equivalent to a ground distance of 4,167 feet on a map with RF of 1/50,000.

(2) A map distance of 1 inch is equivalent

to a ground distance of 3.15 miles on a map with RF of 1/200,000.

(3) A map distance of 1 centimeter is equivalent to a ground distance of 273 yards on a map with RF of 1/25,000.

7-41. Speed Conversion Table, Approximate

<i>Miles per hour</i>	<i>Knots</i>	<i>Feet per second</i>	<i>Kilometers per hour</i>	<i>Meters per second</i>
1	0.8684	1.4667	1.6093	0.447
2	1.74	2.94	3.23	.897
3	2.59	4.41	4.83	1.34
4	3.46	5.90	6.45	1.78
5	4.34	7.33	8.05	2.23
6	5.20	8.80	9.65	2.68
7	6.07	10.30	11.30	3.13
8	6.95	11.80	12.90	3.58
9	7.81	13.22	14.50	4.03
10	8.68	14.67	16.09	4.47
11	9.55	16.20	17.70	4.92
12	10.40	17.62	19.30	5.37
13	11.23	19.10	20.90	5.82
14	12.10	20.60	22.60	6.27
15	13.00	22.10	24.20	6.71
16	13.90	23.50	25.80	7.16
17	14.75	25.00	27.40	7.63
18	15.60	26.40	28.90	8.05
19	16.45	28.00	30.60	8.50
20	17.40	29.30	32.20	8.95
21	18.20	30.90	33.80	9.39
22	19.10	32.30	35.40	9.85
23	20.00	33.80	37.10	10.30
24	20.80	35.30	38.60	10.75
25	21.70	36.70	40.30	11.15
26	22.50	38.20	41.90	11.60
27	23.40	39.70	43.50	12.10
28	24.30	41.20	45.10	12.50
29	25.20	42.60	46.70	13.00
30	26.00	44.20	48.30	13.40
31	26.90	45.60	50.00	13.90
32	27.80	47.00	51.50	14.30
33	28.60	48.50	53.00	14.73
34	29.50	50.00	54.55	15.20
35	30.40	51.50	56.50	15.65
36	31.20	53.00	58.00	16.10
37	32.00	54.50	59.70	16.50
38	32.90	56.00	61.40	17.00
39	33.80	57.50	62.80	17.40
40	34.60	58.80	64.50	17.83
41	35.60	60.50	66.00	18.38
42	36.40	61.90	67.70	18.80
43	37.30	63.40	69.20	19.20
44	38.20	64.80	71.00	19.70
45	38.90	66.50	72.50	20.20
46	40.00	67.50	74.00	20.60
47	40.70	69.10	75.90	21.00
48	41.50	70.50	77.50	21.40
49	42.40	72.00	79.00	21.80
50	43.50	73.80	80.50	22.30

<i>Miles per hour</i>	<i>Knots</i>	<i>Feet per second</i>	<i>Kilometers per hour</i>	<i>Meters per second</i>
51	44.10	74.90	82.00	22.80
52	45.10	76.50	83.60	23.20
53	46.00	78.00	85.70	23.70
54	46.70	79.50	87.00	24.20
55	47.50	80.90	88.70	24.60
56	48.50	82.20	90.00	25.00
57	49.50	83.90	91.90	25.50
58	50.10	85.00	93.40	25.90
59	51.00	86.80	95.00	26.40
60	52.00	88.10	96.70	26.80
61	53.00	89.60	98.00	27.20
62	53.70	91.10	99.80	27.70
63	54.60	92.90	101.70	28.20
64	55.60	94.20	103.00	28.60
65	56.20	95.30	104.50	29.10
66	57.20	97.00	106.00	29.50
67	58.00	98.20	108.00	30.00
68	58.90	100.00	109.50	30.40
69	59.80	101.80	111.00	30.80
70	60.70	103.00	113.00	31.30
71	61.60	104.00	114.00	31.70
72	62.50	106.00	116.00	32.20
73	63.30	107.30	117.30	32.60
74	64.20	109.00	119.00	33.10
75	65.00	110.00	121.00	33.60

7-42. Conversion of Foreign Measures to United States Measures

<i>Country</i>	<i>Weight or measure</i>	<i>U.S. equivalent</i>
Argentina	Arroba	25.32 lb
	Baril	20.077 gal.
	Cuadra	4.2 acres
	Frasco (liq)	2.509 qt (liq)
	Last	58.4 bu
	Libra	1.013 lb
	Pie	0.947 ft
	Quintal	101.28 lb
	Vara	34.094 in.
Australia	Same as United Kingdom	
Austria	Joch	1,422 acres
	Klafter	2.074 yd
Belgium	Last	85.134 bu
Bolivia	Marc	0.507 lb
Borneo	Picul	135.64 lb
Brazil	Arroba	32.379 lb
	Quintal	120.54 lb
Canada	Same as United Kingdom	
Celebes	Picul	135.64 lb
Central America	Ara	32.913 in.
	Centore	4.263 gal.
	Fanega	1.574 bu
	Libra	1.014 lb
	Manzama	1.727 acres
Chile	Fanega	2.753 bu
	Libra	1.014 lb
	Quintal	101.41 lb
	Vara	32.913 in.

<i>Country</i>	<i>Weight or measure</i>	<i>U.S. equivalent</i>
China	Catty	1.333 lb
	Chang	10.49 ft
	Ch'ih	12.6 in.
	Chun	1.26 in.
	Feng	0.1259 in.
	Hou	0.0013 in.
	Li	1,890 ft
	Picul	133.333 lb
	Shi li	1,889.28 ft
	Shih tan	110.23 lb
	Tael Kuping	575.64 grains (troy)
	Tsun	1.409 in.
Cuba	Libra	1.014 lb
	Vara	33.386 in.
Denmark	Centner	110.23 lb
	Mil	4.68 miles
	Mil (geographic)	4.61 miles
	Pund	1.102 lb
	Tende (grain)	3.948 bu
	Tondeland	1.36 acres
	Viertel	1.701 gal.
Dutch Guiana	Livre	1.089 lb
Ecuador	Fanega	1.574 bu
Egypt	Ardeb	5.619 bu
	Cantar	99.05 lb
	Feddan	1.04 acres
	Oke	2.805 lb
	Pic	22.83 in.
France	Tonne	2,204.62 lb
Germany	Klafter	2.074 yd
	Last	4,409.2 lb
	Centner	127.5 lb
Bremer	Centner	117.5 lb
Brunswick	Centner	113.34 lb
Prussia	Centner	113.34 lb
Greece	Drachma (new)	1 metric gr
	Livre	1.1 lb
	Mina (old)	2.202 lb
	Oke	2.82 lb
Guatemala	Fanega	1.53 bu
	Libra	1.014 lb
	Vara	32.909 in.
Honduras	Milla	1.149 miles
	Vara	32.953 in.
Hong Kong	Catty	1.333 lb
	Picul	133.333 lb
Hungary	Joch	1.067 acres
India:		
Bombay	Candy	569 lb
Madras	Candy	500 lb
	Chittak	900 grains
	Maund (standard)	82.285 lb
	Seer (factory)	1.866 lb
	Seer (standard)	2.057 lb
	Ser	2.204 lb
	Tola	0.4114 oz
	Buow	1.7536 acres
Indonesia	Katti	1.36 lb
	Paal	56.16 acres

Country	Weight or measure	U.S. equivalent
Java	Paal	1,506 meters
Sumatra	Paal, square	1,852 meters
	Picul	136.16 lb
Iran	Jarib	2.471 acres
Israel	Rottle	6.35 lb
Japan	Bu	0.12 in.
	Catty	1.32 lb
	Cho	2.451 acres
	Go	0.19 qt
	Jo	3.31 yd
	Ken	5.97 ft
	Kin	1.323 lb
	Koku	5.119 bu
	Koku	47.65 gal.
	Kwamme	8.267 lb
	Kwan	8.267 lb
	Momme	0.1333 oz.
	Picul	132.3 lb
	Ri	2.44 miles
	Rin	0.012 in.
	Se	0.024 acres
	Shaku	11.93 in.
	Sho (liq)	1.91 qt (liq)
	Sun	1.193 in.
	Tan	0.25 acres
	To	2.05 pk
	Tsubo	35.58 sq ft
	Tsunbo	3.953 sq ft
Korea	Chungbo	105.49 sq ft
	Ja	1 ft
	Kwan	3.750 kg or 8.269 lb
	Ri	2.440 miles
	Sok	6.371 cu ft
Luxemburg	Fuder	264.18 gal.
Malacca	Catty	1.36 lb
Malaya	Bongkal	832.0 grains
Malta	Barrel (Customs)	11.2 gal.
	Caffisco	5.4 gal.
	Cantaro	175 lb
	Salm	8.2 bu
Mexico	Baril	20.078 gal.
	Fanega	2.577 bu
	Frasco (liq)	2.5 qt (liq)
	Libra	1.014 lb
	Quintal	101.47 lb
	Vara	32.99 in.
Morocco	Artel	1.12 lb
	Cantar	112 lb
Nicaragua	Manzana	1.742 acres
	Milla	1.159 miles
	Vara	33.057 in.
Norway	Centner	110.23 lb
Paraguay	Arroba	25.32 lb
	Cuadra (lin)	94.7 yd
	Cuadra (sq)	1.85 yd
	League	4.633 acres

<i>Country</i>	<i>Weight or measure</i>	<i>U.S. equivalent</i>
Peru	Libra	1.014 lb
	Quintal	101.43 lb
	Vara	31.913 in.
Philippines	Picul	139.44 lb
Poland	Garnice	1.056 gal.
	Vloka	41.5 acres
Portugal	Almude	4.422 gal.
	Li'ra	1.012 lb
Spain	Arroba	4.263 gal.
	Fanega	16 gal.
	Pie	0.914 ft
	Quintal	101.43 lb
Sweden	Centner	93.7 lb
	Last	9,371.3 lb
	Skalpund	0.937 lb
	Tunna	4.5 bu
	Tunnland	1.22 acres
Thailand	Catty, standard	1.333 lb
	Catty	2.667 lb
	Coyan	2,645.5 lb
Turkey	Cantar	124.45 lb
	Oke	2.828 lb
	Pik	27.9 in.
	Archine, or Archinne	28 in., or 0.7112 meter
U.S.S.R.	Berkovets	361.128 lb
	Chetvert	5.957 bu
	Dessiatine	2.70 acres
	Duim	1 in.
	Founte, or Funt	0.903 lb
	Foute, or Fut	1 ft
	Garnetz	2.978 qt (dry)
	Poud, or pood	36.113 lb
	Sagene, or Sajene	7 ft
	Vedro	3.25 U.S. gal., 2.71 imperial gal.
	Versta, or Verst	0.663 mile
United Kingdom	Comb	4.128 bu
	Cwt (hundred wt)	112.0 lb
	Gallon	1.2 gal.
	Last	82.56 bu
	Load	50 cu ft
	Quart (liq)	1.2 qt (liq)
	Quart (dry)	1.3 qt (liq)
	Quarter	8.256 bu
	Sack (flour)	280 lb
	Stone	14 lb
	Wey	41.282 bu
Uruguay	Cuadra	1.82 acres
	Fanega	3.888 bu
	Libra	1.014 lb
Venezuela	Fanega	3.334 bu
	Libra	1.014 lb
Yugoslavia	Wagon	10 metric tons
Zanzibar	Frasila	35 lb

7-43. Miscellaneous Conversion Factors for U.S. and British Measures

<i>Multiply</i>	<i>By</i>	<i>To obtain</i>
Atmosphere	14.70	Pounds per square inch
Barrels	5.61	Cubic feet
Barrels	42.0	Gallons
Barrels	6.29	Kiloliters
Board feet	144.0	Cubic inches
Boiler horsepower	33,475.0	Btu per hour
Bushels (imperial)	1.032	Bushels (U.S.)
Bushels (U.S.)	.969	Bushels (imperial)
Carat	3.086	Grains
Centimeters	.03281	Feet
Centimeters	.3937	Inches
Cubic feet	.782	Barrels
Cubic feet	.02832	Cubic meters
Cubic feet	.01	Tons (register)
Cubic feet per minute	.1247	Gallons per second
Cubic feet per second	646,315.0	Gallons per day
Cubic meters	35.31	Cubic feet
Cubic meters	1.308	Cubic yards
Cubic yards	.7646	Cubic meters
Days	1,440.0	Minutes
Drams	1.772	Grams
Drams	.0625	Ounces
Feet	30.48	Centimeters
Feet of water	.8826	Inches of mercury
Feet of water	62.43	Pounds per square foot
Feet of water	.4335	Pounds per square inch
Gallons (imperial)	.1605	Cubic feet
Gallons (imperial)	1.201	Gallons (U.S.)
Gallons (imperial)	4.543	Liters
Gallons (U.S.)	.8327	Gallons (Imperial)
Gallons (U.S.)	.0238	Barrels
Gallons per minute	.002228	Cubic feet per second
Grams	15.43	Grains
Grams	.001	Kilograms
Grams	1,000.0	Milligrams
Grams	.03527	Ounces
Grams	.002205	Pounds
Hours	.04167	Days
Hours	.005952	Weeks
Horsepower	42.40	Btu per minute
Horsepower	33,000.0	Foot-pounds per minute
Horsepower (boiler)	33,475.0	Btu per hour
Horsepower-hours	2,545.0	Btu
Hundredweight	112.0	Pounds
Hundredweight	.508	Quintals
Inches	2.540	Centimeters
Inches	25.4001	Millimeters
Inches	1,000.0	Mils
Inches of mercury	.4912	Pounds per square inch
Inches of water	.07355	Inches of mercury
Inches of water	.03614	Pounds per square inch
Kilograms	1,000.0	Grams
Kiloliters	.159	Barrels
Knots	1.0	Miles per hour (naut)
Links (surveyors)	7.92	Inches
Liters	.2642	Gallons (U.S.)
Liters	1.76	Pint (Imperial)

<i>Multiply</i>	<i>By</i>	<i>To obtain</i>
Liters	2.1134	Pint (U.S.)
Liters	1.057	Quart (liquid)
Meters	100.0	Centimeters
Millimeters	.0393	Inches
Mils	.001	Inches
Ounces	20	Pennyweights
Ounces	28.349	Grams
Ounces (fluid)	1.805	Cubic inches
Pennyweight	24	Grains
Pounds	453.0	Grams
Pounds of water	.01603	Cubic feet
Pounds of water	.1198	Gallons (U.S.)
Pounds per square inch	2.307	Feet of water
Pounds per square inch	2.036	Inches of mercury
Quintals	1.97	Hundredweights
Quires	25.0	Sheets (of paper, etc.)
Reams	500.0	Sheets (of paper, etc.)
Short ton-miles	1.45968	Metric ton-kilometers
Square centimeters	.1550	Square inches
Square feet	929.0	Square centimeters
Square feet	144.0	Square inches
Square inches	6.452	Square centimeters
Stones	14.0	Pounds
Temp (°C) plus 17.8	1.8	Temp (°F)
Temp (°F) minus 32	.5556	Temp (°C)
Tons (measurement)	40.0	Cubic feet
Tons (register)	100.0	Cubic feet
Weeks	168.0	Hours

Section XII. STOWAGE FACTORS

7-44. Stowage Factors by Class and Service

a. *Computation of Stowage Factor.* The stowage factor is the number of cubic feet required to store 1 long ton (2,240 lb) of cargo. It may be computed by the following formula.

$$\text{Stowage factor (cu ft)} = \frac{\text{cube of cargo (cu ft)}}{\text{weight in pounds}} \times 2,240$$

b. *Weight-Volume Ratios.* Weight-volume ratios are based on average cubage for each item. The measurement tonnage for any item can be found by multiplying its short ton weight by its conversion factor. Weight-volume ratios by classes of supply are given below.

<i>Item</i>	<i>Conversion factor (STON to MTON)</i>	<i>Stowage factor</i>
Class I: Rations	2.1	94
Class II:		
Chemical (incl. class IV) ..	2.3	103
Engineer	3.3	147
Medical (incl. class I and IV).	2.5	112
Ordnance	1.8	80
Ordnance vehicle replacement.	2.2	99
QM clothing and equipage ..	2.0	89
QM general supplies	2.8	125
Signal (incl. class IV)	3.8	170
Class III:		
Aviation fuel and lubricants (class IIIA).	1.5	67
Fuel for temperate zone	2.0	89
Gas, oil, grease * (less aviation).	1.5	67
Class IV:		
Aviation, supply and replacement.	4.0	179
Chemical (incl. in class II)		
Engineer construction material.	1.5	67
Medical (incl. in class II)		
Ordnance motor maintenance.	1.0	45
QM sales items	1.7	76
Signal (incl. in class II)		
Transportation	2.4	108

See footnotes at end of table.

Item ¹	Conversion factor (STON to MTON)	Stowage factor
Class V:		
Ammunition (less aviation)	.9	40
Aviation ammunition	.9	40
Chemical ammunition	1.2	54

¹ Nongas conditions. Figures are based upon average conditions found in European and Pacific theaters; amounts will vary for polar regions.

² Consists of the following: 90 percent gasoline, 4 percent diesel fuel, 3 percent engine oil, 1 percent gear lube, 2 percent greases.

7-45. Average of Stowage Factors by Service

Supply service	Class of supply	Stowage factor
Chemical	All supplies less Class V	103
Engineer	All supplies	107
Medical	All supplies	112
Ordnance	All supplies less Class V	75
Quartermaster	All supplies	87
Signal	All supplies	170
Transportation	All supplies	108
Chemical	Class V	54
Ordnance	Class V	40

7-46. Average Densities of Common Materials and Specified Supply Items

Figures shown below will aid transportation planners and operators when making loading plans for any mode of transportation. The information given is for specific items. When planning loads for the general classes of supply, see paragraphs 7-8, 7-28, 7-44, 7-45.

a. Common Materials.

Material	Weight (lb per cu ft)
Acid:	
Muriatic, 40%	75
Nitric, 91%	94
Sulphuric, 87%	112
Alcohol, 100%	
Ethyl	49
Methyl	50
Aluminum, cast-hammered	165
Apple timber	44
Asbestos	153
Ashes and cinders	40-45
Asphaltum	81
Ash timber:	
Black	34
White	42
Barley	39
Barytes	281
Basalt	184
Bauxite	159
Benzine	50
Birch timber	44
Bluestone	159

Material	Weight (lb per cu ft)
Borax	109
Boxwood, dry	60
Brass, cast-rolled	534
Bronze:	
Aluminum	481
Phosphor	554
Tin	509
Brick	100
Calcium	98
Carbon	134
Cedar timber, white or red	22
Cement:	
Mortar	135
Portland, loose, dry	94
Portland, set	183
Chalk	143
Chestnut timber	30
Cherry timber, wild red	27
Chloroform	95
Cinders:	
Blast furnace	57
Chemical plant	100
Clay:	
Damp, plastic	110
Dry	63
Marl (mineral)	137
Wet	80
With gravel, dry	100
Coal:	
Anthracite	97
Bituminous	84
Charcoal, oak	33
Charcoal, pine	23
Coke	75
Lignite	78
Peat, turf, dry	47
Coal and coke, piled:	
Anthracite	47-58
Bituminous or lignite	40-54
Charcoal	10-14
Coke	23-32
Peat, turf	20-26
Cobalt	546
Concrete:	
Plain	140-150
Reinforced	150
Copper:	
Cast-rolled	556
Ore, pyrites	262
Cork	15
Cotton, compressed	45
Dolomite	181
Earth:	
Dry, loose	76
Dry, packed	95
Moist, loose	78
Moist, packed	96
Mud, flowing	108
Mud, packed	115

Material	Weight (lb per cu ft)
Ebony timber	78
Elm timber	35
Ether	46
Excelsior, baled	19
Feldspar, orthoclase	162
Fir timber:	
Balsam	25
Douglas	32
Flax	26
Flint	162
Garbage:	
Green	47
Tankage	27
Glass:	
Common	162
Crystal	184
Flint	247
Plate or crown	161
Gneiss	175
Gold:	
Cast-hammered	1,205
Coin (U.S.)	1,073
Grain	48
Granite	165
Graphite	135
Gravel:	
Damp, loose	87
Dry, compacted	120
Greenstone, trap	187
Gumwood	57
Gypsum, alabaster	159
Hay or straw (bales)	20
Hemlock timber	29
Hemp	90
Hickory timber	48
Hornblende	187
Ice	57
Indigo	68
Iridium	1,383
Iron:	
Cast pig	450
Ferrosilicon	437
Gray cast	442
Ore:	
Hematite	325
Hematite in bank	160-180
Hematite loose	130-160
Limonite	237
Magnetite	315
Slag	172
Spiegel-eisen	468
Wrought	485
Ivory	114
Jute	30
Kerosene	50
Lead:	
Pure	710
Ore, galena	465
Leather	59

Material	Weight (lb per cu ft)
Lime, gypsum, loose	53-64
Limestone:	
Marble, quartz (solid)	155
Marble, quartz (quarried, piled)	95
Locust timber	45
Logwood, dry (average)	57
Lumber, structural (average)	24
Lye, soda (liquid)	106
Magnesite	187
Magnesium alloys	112
Mahogany timber	44
Manganese:	
Pure	475
Ore, pyrolusite	259
Manila	26
Maple timber:	
Hard or sugar	43
White	33
Marble	170
Masonry:	
Ashlar:	
Bluestone	153
Granite, syenite, gneiss	159
Limestone	153
Marble	162
Sandstone	143
Brick:	
Hard brick	128
Medium brick	112
Sand-lime brick	112
Soft brick	103
Concrete:	
Cement, cinder, etc	100
Cement, slag, etc	130
Cement, stone, sand	144
Dry rubble:	
Granite, syenite, gneiss	130
Limestone, marble	125
Sandstone, bluestone	110
Mortar rubble:	
Bluestone	147
Granite, syenite, gneiss	153
Limestone	147
Marble	156
Sandstone	137
Mercury	847
Mica	183
Monel metal, rolled	555
Mortar:	
Lime, set	103
Portland cement	135
Mud (river mud)	90
Nickel	537
Oak timber:	
Chestnut	46
Live	54
Red or black	42
White	48
Oats	26

Material	Weight (lb per cu ft)	Material	Weight (lb per cu ft)
Oils:		Slate	172
Mineral (lubricants)	57	Silver:	
Vegetable	58	Cast-hammered	656
Paper:		German	536
Books	58	Sisal	24
Manila	37	Slags:	
News	38	Bank	67-72
Wrapping	10	Bank screenings	98-117
Writing	64	Machine	96
Paraffin	56	Slag-sand	49-55
Petroleum, crude (average)	54	Snow:	
Phosphate rock, apatite	200	Compacted	20
Phosphoric acid	97	Fresh	8
Pine timber:		Soapstone, talc	169
Norway	34	Soda ash	62
Oregon	32	Soda, bicarbonate	86
Red	30	Sodium	61
Southern	40	Soil, wet	70
White	27	Spruce timber, white or red	28
Yellow:		Starch	96
Long-leaf	44	Steel:	
Short-leaf	38	Cold-drawn	489
Pitch	69	Machine	487
Plaster	53	Tool	481
Plaster of Paris	140	Stone riprap, wet	65
Platinum, cast-hammered	1,330	Straw:	
Poplar timber	27	Baled	24
Porphyry (mineral)	172	Loose	3
Potassium	54	Sulphur	125
Pumice, natural	40	Sulphuric acid	115
Quartz, flint	165	Sycamore timber	37
Rags, baled:		Syenite (mineral)	165
Cotton	18	Talc	170
Linen	23	Tallow	59
Woolen	20	Tar, bituminous	75
Redwood timber (California)	26	Teak timber:	
Riprap:		African	62
Limestone	80-85	Indian	48
Sandstone	90	Terra Cotta	122
Shale	105	Tin:	
Rope	42	Cast-hammered	459
Rosin	67	Orè, cassiterite	418
Rubber:		Tobacco	28
Caoutchouc	59	Tungsten	1,200
Goods	94	Turpentine	54
Pure	60	Walnut timber:	
Rye	45	Black	37
Salt, granulated, piled	48	White	26
Saltpeter	132	Water:	
Sand and gravel:		Fresh	62
Dry, loose	90-105	Sea	64
Dry, packed	105-120	Wax, bees	61
Wet	126	Wheat	48
Sandstone	143	Willow timber	28
Sandstone, quarried, piled	82	Wood pulp	29
Sawdust, dry	7	Wool, packed	82
Serpentine (mineral)	171	Zinc:	
Shale:		Cast-rolled	440
Quarried, piled	92	Ore, blende	253

*b. Subsistence.**(1) Perishables and bulk staples.*

<i>Material</i>	<i>Weight (lb per cu ft)</i>
Dairy Products:	
Butter	59.0
Cheese	30.0
Milk	65.0
Eggs	22.6
Fruits:	
Fresh:	
Apples	31.3
Apricots	34.8
Bananas	13.2
Blackberries	21.5
Cantaloupe	26.8
Casaba (honeydew melon)	24.0
Cherries	31.2
Cranberries	24.6
Figs	34.8
Grapefruit	31.2
Grapes	28.9
Lemons	33.2
Limes	36.9
Loganberries	21.1
Oranges	34.2
Peaches	23.3
Pears	24.9
Pineapples	22.1
Plums	25.6
Raspberries	22.0
Strawberries	22.0
Tangerines	35.5
Frozen (average for all)	36.2
Meats:	
Beef:	
Boneless	36.7
Chuck	35.8
Corned	37.1
Dried, canned	39.8
Forequarter	27.0
Hindquarter	19.1
Liver	45.7
Loin	18.1
Rounds	14.7
Ribs	23.3
Tenderloin	46.6
Lamb and Mutton:	
Carcass	9.4
Telescope	11.5
Pork:	
Bacon	36.9
Boston butt	40.2
Ham	40.2
Ham, canned	37.4
Loin	37.4
Pork shoulder	30.9
Salt pork	33.5
Spare rib	30.9
Poultry:	

<i>Material</i>	<i>Weight (lb per cu ft)</i>
Chicken, dressed:	
Fryer	31.5
Hen	40.2
Chicken, cut-up	29.6
Turkey	29.3
Sausage:	
Bologna	32.5
Frankfurter	35.2
Liver	36.5
Luncheon meat	37.8
Pork, bulk	46.6
Pork, link	35.2
Salami	34.8
Veal:	
Carcass and sides	13.7
Fabricated	14.6
Staples:	
Bread	18.0
Cereals, bulk:	
Barley	39.0
Buckwheat	42.0
Corn, rye	45.0
Oatmeal	38.0
Oats	26.0
Wheat	48.0
Coffee	37.0
Cornmeal	40.0
Fats (average)	58.0
Flour:	
Loose	28.0
Packed	47.0
Honey	90.0
Lard	60.0
Molasses	38.0
Rice	50.0
Sugar:	
Brown	45.0
White	42.0
Tea	16.0
Vegetables:	
Fresh:	
Asparagus	21.0
Beans:	
Green or snap	14.7
Lima	18.3
Beets:	
Bunched	18.1
Topped	30.9
Broccoli	17.8
Cabbage	24.5
Carrots:	
Bunched	18.9
Topped	30.0
Cauliflower	18.9
Celery	23.4
Corn, sweet	16.8
Cucumbers	23.1
Eggplant	16.4
Lettuce	20.5

Material	Weight (lb per cu ft)
Onions:	
Dry	30.9
Green	16.8
Peas:	
Green	14.4
Shelled	26.0
Peppers, sweet, green	17.6
Potatoes:	
Irish	35.7
Sweet	31.3
Radishes	21.6
Spinach	14.8
Tomatoes	33.3
Turnips	30.9
Frozen (average for all)	27.0
Water food:	
Clams	28.2
Crab meat	27.1
Fish:	
Drawn	32.8
Fillet	22.1
Smoked	24.6
Smoked fillet	51.6
Oysters	26.5
Shrimp	23.9

(2) *Nonperishables in containers.*

Material	Weight (lb per cu ft)
Apples	
(No. 10 can)	40.0
(No. 2 1/2 can)	37.9
(No. 2 can)	38.0
Apple butter	
(No. 10 can)	47.5
(No. 2 1/2 can)	45.0
(No. 2 can)	44.5
Apples, dry (50-lb bag)	33.3
Apricots	
(No. 10 can)	43.8
(No. 2 1/2 can)	42.1
(No. 3 can)	41.0
Bacon (12-lb slab)	37.6
Beans	
(No. 10 can)	43.8
(No. 2 1/2 can)	42.1
(No. 2 can)	41.0
(No. 1 can)	50.7
Beans, dry (100-lb sack)	39.2
Beans, string	
(No. 10 can)	41.6
(No. 2 1/2 can)	40.0
(No. 2 can)	39.5
Beef, canned (6-lb can)	62.0
Beef, roast (No. 10 can)	42.5
Beets	
(No. 10 can)	42.5
(No. 2 1/2 can)	40.0
(No. 2 can)	41.0

Material	Weight (lb per cu ft)
Biscuits, Types C (2-lb pack)	28.8
Bouillon cubes (100 per pack)	37.3
Butter (5-lb pack)	45.6
Cabbage, dehy (5-lb pack)	13.8
Candy, hard (15-lb pack)	33.1
Carrots	
(No. 10 can)	42.5
(No. 2 1/2 can)	40.0
(No. 2 can)	41.0
Catsup	
(No. 10 can)	45.0
(No. 2 1/2 can)	42.1
(No. 2 can)	41.0
Cereal, uncooked (22 oz)	32.7
Cereal, individual	8.7
Cheese, processed (6-lb pack)	54.4
Chile con carne	
(No. 10 can)	42.5
(No. 2 1/2 can)	40.0
(No. 2 can)	41.0
Cocoa (5-lb pack)	25.0
Coffee (16-lb bag)	30.0
Corn	
(No. 10 can)	43.2
(No. 2 1/2 can)	41.1
(No. 2 can)	41.0
Crackers, Graham (2-lb pack)	30.0
Eggs, dehy (No. 10 can)	25.0
Figs	
(No. 10 can)	45.0
(No. 2 1/2 can)	42.1
(No. 2 can)	42.5
Flour (98-lb sack)	36.1
Grapefruit	
(No. 10 can)	41.6
(No. 2 1/2 can)	40.0
(No. 2 can)	39.5
Hash, corned beef (5 1/2-lb pack)	33.1
Hash, meat and veg (No. 10 can)	43.8
Jam, assorted	
(No. 10 can)	52.5
(No. 2 1/2 can)	41.0
(No. 2 can)	47.0
Lard (37-lb container)	46.8
Luncheon meat (6-lb pack)	49.5
Mackerel (14-oz can)	26.7
Milk, powdered (5-lb container)	31.3
Milk, evaporated (14 1/2-oz pack)	42.3
Oats, rolled (48-oz pack)	20.9
Peaches and/or pears:	
(No. 10 can)	43.8
(No. 2 1/2 can)	41.1
(No. 2 can)	42.5
Peanut butter	
(No. 10 can)	43.8
(No. 2 1/2 can)	41.1
(No. 2 can)	41.0

<i>Material</i>	<i>Weight (lb per cu ft)</i>
Peas	
(No. 10 can)	42.8
(No. 2 can)	41.0
Pickles (1-gallon jar)	48.5
Pineapple, sliced:	
(No. 10 can)	43.8
(No. 2 1/2 can)	42.1
(No. 2 can)	41.0
Pineapple juice	
(No. 10 can)	41.7
(No. 2 can)	41.0
Potatoes, dehy	
(No. 16-lb pack)	33.0
(No. 10-lb pack)	24.7
Prunes, dry	
(No. 25-lb bag)	60.0
(No. 5-lb bag)	44.4
Salmon (1-lb container)	47.7
Salt (100-lb bag)	39.2
Sauerkraut	
(No. 10 can)	40.9
(No. 2 1/2 can)	38.9
(No. 2 can)	39.5
Sausage (2-lb pack)	44.3
Sausage, Vienna (1 1/2-lb pack)	36.7
Soup, dehy (5-lb pack)	28.6
Spaghetti	
(No. 10 can)	43.2
(No. 2 1/2 can)	41.1
(No. 2 can)	41.0
Spinach	
(No. 10 can)	40.6
(No. 2 1/2 can)	38.9
(No. 2 can)	38.0
Stew, meat and veg	
(28-oz pack)	40.7
(30-oz pack)	43.6
Sugar, granulated:	
(10-lb pack)	56.4
(100-lb pack)	40.0
Syrup	
(No. 10 can)	52.2
(1-lb container)	62.1
Tea (5-lb box)	13.0
Tomatoes	
(No. 10 can)	41.9
(No. 2 1/2 can)	40.0
(No. 2 can)	39.5
Tomato juice	
(No. 10 can)	41.6
(No. 2 1/2 can)	40.0
(No. 2 can)	39.5
Vegetables, mixed:	
(No. 10 can)	42.5
(No. 2 can)	39.5
Vinegar (1-gal. jar)	67.0

c. Clothing and Individual Equipment.

<i>Material</i>	<i>Weight (lb per cu ft)</i>
Axe, chopping	20
Bag, barracks	18
Bag, duffel	22
Bag, sleeping	17
Bar, mosquito	20
Belt, cartridge	20
Belt, pistol	22
Blanket, wool, OD	16
Boots, service, combat	18
Bunting wool	21
Can, meat, aluminum	13
Canteen, aluminum	9
Cap, garrison, AG 44	18
Cap, service, wool	4
Carrier, pack	16
Case, canvas, dispatch	13
Coat, wool	14
Comforter, wool	7
Cover, canteen	11
Cup, canteen, aluminum	11
Drawers, cotton	21
Drawers, winter	18
Gloves, cotton	18
Gloves, leather	25
Gloves, wool	11
Handkerchief	25
Haversack	19
Helmet, steel, boxed	15
Holster (Various types)	15
Jacket, field	21
Jumper, dungaree	21
Laces, shoe	20
Liner, helmet	6
Mittens, inserts	16
Muffler, wool, OD	12
Necktie, mohair	15
Overcoat (w/wool insert)	20
Pack, field, cargo	19
Pack, field, combat	18
Pants, sweat	20
Parka, field, cotton	23
Pin, tent	27
Pocket, cartridge	18
Pocket, magazine	25
Pole, tent, shelter	28
Pouch, first aid	15
Raincoat	30
Roll, bedding	32
Rope, manila	15
Scabbard, rifle	13
Shirt, cotton, khaki	20
Shirt, wool, OG	23
Shoes, low quarter	11
Shovel, intrenching	28
Socks, cotton	16
Socks, wool	14
Suit, HBT, protective	22

Material	Weight (lb per cu ft)
Sweater, wool	15
Tent, shelter half	23
Towel, bath	15
Trousers, cotton, khaki	22
Trousers, wool serge	23
Undershirt, cotton	18

d. Organizational Field Equipment.

Material	Weight (lb per cu ft)
Cans, galvanized:	
10-gal	17.6
24-gal	7.9
32-gal	8.4
Chair, folding, metal	12.8
Chair, folding, wood	11.0
Chest, record, fiber	9.0
Container, insulated	16.0
Container, water, 5-gal	11.6
Cot, canvas, folding	27.0
Cover, mattress	24.0
Desk, field, empty, fiber	9.0
*Duck, cotton	32.0
*Fly, tent, wall	30.0
Kit, barber	23.0
Locker, trunk	9.0
Mattress, cotton	4.0
*Paulin, canvas, small	21.0
*Paulin, canvas, large	43.0
Pillow, feather	8.0
Pillowcase	21.0
Pin, tent, 16"	36.3
Pin, tent, 24"	30.2
Pole, tent, ridge	27.0
Range, field	22.7
*Screen, latrine	27.1

Material	Weight (lb per cu ft)
Table, camp, folding	9.2
Table, mess	1.8
*Tent, command post	11.7
*Tent, GP, med	23.9
*Tent, storage	36.3
*Tent, wall, small	13.0
*Tent, wall, large	25.0

*Figures are average. Weight will vary with different types of material.

7-47. Rapid Computation of Weight of a Unit for Shipment

For planning purposes, the weight in short tons of a unit is the sum of the combined weights of—

a. TOE personnel and individual equipment, assuming average weight of 240 pounds per man.

b. Major items of organizational equipment.

c. Class I supplies for 3 days, assuming 6.6 pounds per ration per man per day.

d. Class III supplies necessary to move unit 100 miles from destination point after arrival, if authorized in shipment.

e. Basic load of class V.

f. Added items that may be authorized by theater commander or CONUS commander.

Section XIII. MATHEMATICAL TABLES AND FORMULAS

7-48. Measurement of Surfaces and Solids

Figure	Formula
a. Area of:	
Circle	Square of the diameter times .7854, or square of the radius times 3.1416.
Sector of	Length of the arc times the radius divided by 2, or 3.1416 times square of radius times angle of the sector divided by 360.
Segment of	Area of the sector minus the area of the triangle formed by joining radii.
Closed base cone	One-half of slant height times perimeter of base, plus area of base.

Figure	Formula
Open base cone	One-half of slant height times perimeter of the base.
Frustrum of cone	Slant height times sum of circumferences of bases divided by 2 plus sum of the areas of both bases.
Cube	Sum of areas of all the sides.
Cylinder	Area of 2 ends plus length times perimeter.
Ellipse	Long axis times short axis times .7854.
Parallelogram	Base times altitude.
Polygon	Perimeter times apothem divided by 2.
Prism	Area of 2 ends plus length times perimeter.

Figure	Formula
Pyramid -----	One-half of slant height times perimeter of base plus area of base.
Rectangle -----	Bases times altitude.
Sphere -----	Square of diameter times 3.1416.
Square -----	Base times altitude.
Straight-lined figure of 4 or more unequal sides.	Divide figure into triangles, find area of each triangle, and add areas.
Trapezoid -----	Altitude times sum of bases divided by 2.
Triangle -----	Base times altitude divided by 2.
b. Circumference of:	
Circle -----	Diameter times 3.1416.
Quadrilateral and Polygon.	Sum of all sides.
c. Volume of:	
Cone -----	Height times area of base divided by 3.
Frustrum of cone --	Height times $\frac{(B + B' + \sqrt{B \times B'})}{3}$
Cube -----	Length times width times depth.
Cylinder -----	Area of the base times height.
Prism -----	Height times area of base.
Pyramid -----	Height times area of base divided by 3.
Frustrum of pyramid.	Height times $\frac{(B + B' + \sqrt{B \times B'})}{3}$
Sphere -----	Cube of the diameter times .5236.
Tank, elliptical ----	Long axis times short axis times .7854 times length.
Irregular figure ----	Sum of volume of component parts. If possible, immerse figure in water and measure the displacement.

Note.

Apothem -----	perpendicular from center of polygon to any side.
B and B' -----	area of upper and lower bases respectively, of frustrum of cone or pyramid.
Frustrum -----	that part of a pyramid or cone included between the base and a section of the pyramid or cone parallel to the base.
Polygon -----	closed, straight-lined figure having more than 4 sides.
Quadrilateral -----	closed, straight-lined figure having 4 sides.
Regular polygon --	closed, straight-lined figure having equal sides and equal angles.

Figure	Formula
Trapezoid -----	quadrilateral figure having one pair of parallel sides.

7-49. Functions of Numbers

Quantities in the chart below are useful to the transportation planner when solving equations and formulas. Logarithms are particularly useful if a number is to be raised to a power above the cube or to a fractional power. The logarithm of a number is the exponent of the power to which a base must be raised to produce the number. For the purposes of this manual, the base can be considered to be 10. Therefore, the logarithm of a number to the base 12 is the power to which 16 must be raised to produce the number.

For example.

$$\text{Log}_{10} 100 = 2.00000, \text{ since } 10^{2.00000} = 100$$

A logarithm has two parts—the characteristic (that part to the left of the decimal point), and a mantissa (that part to the right of the decimal point). The mantissa is always arranged to be positive. The characteristic is zero or positive and is one less than the number of digits to the left of the decimal point for one and numbers greater than one, and is negative and a minus one greater than the number of zeros to the right of the decimal point for numbers smaller than one. Thus the logarithm of 0.01 is 2.00000, which may also be expressed as (1.00000-3), (2.00000-4), (3.00000-5), etc. In keeping the mantissa positive for numbers smaller than one, should there be a multiplier of the logarithm, the number to the right in the brackets should be the lowest possible number that will produce a whole number from the multiplier. For example, should the logarithm of a number equal $\frac{1}{3} \times 1.00000$, it should be expressed as $\frac{1}{3} \times (2.00000-3)$, which equals 0.66666-1, or 1.66666. An example of the use of logarithms is presented by the problem of raising 44 to the 0.36 power.

$$\text{Let } x = (44)^{0.36}$$

$$\begin{aligned} \text{The log } x &= 0.36 \times \log 44 \\ &= 0.36 \times 1.64345 \\ &= 0.59164 \end{aligned}$$

$$\text{and } x = \text{antilog of } 0.59164, \text{ or } 3.905.$$

<i>Number</i>	<i>Square</i>	<i>Square root</i>	<i>Cube</i>	<i>Cube root</i>	<i>Logarithm</i>
1	1	1.0000	1	1.000	0.00000
2	4	1.4142	8	1.260	.30103
3	9	1.7321	27	1.442	.47712
4	16	2.0000	64	1.587	.60206
5	25	2.2361	125	1.710	.69897
6	36	2.4495	216	1.817	.77815
7	49	2.6458	343	1.913	.84510
8	64	2.8284	512	2.000	.90309
9	81	3.0000	729	2.080	.95424
10	100	3.1623	1000	2.154	1.00000
11	121	3.3166	1331	2.224	1.04139
12	144	3.4641	1728	2.289	1.07918
13	169	3.6056	2197	2.351	1.11394
14	196	3.7417	2744	2.410	1.14613
15	225	3.8730	3375	2.466	1.17609
16	256	4.0000	4096	2.520	1.20412
17	289	4.1231	4913	2.571	1.23045
18	324	4.2426	5832	2.621	1.25527
19	361	4.3589	6859	2.668	1.27875
20	400	4.4721	8000	2.714	1.30103
21	441	4.5826	9261	2.759	1.32222
22	484	4.6904	10648	2.802	1.34242
23	529	4.7958	12167	2.844	1.36173
24	576	4.8990	13824	2.884	1.38021
25	625	5.0000	15625	2.924	1.39794
26	676	5.0990	17576	2.962	1.41497
27	729	5.1962	19683	3.000	1.43136
28	784	5.2915	21952	3.037	1.44716
29	841	5.3852	24389	3.072	1.46240
30	900	5.4772	27000	3.107	1.47712
31	961	5.5678	29791	3.141	1.49136
32	1024	5.6569	32768	3.175	1.50515
33	1089	5.7446	35937	3.208	1.51851
34	1156	5.8310	39304	3.240	1.53148
35	1225	5.9161	42875	3.271	1.54407
36	1296	6.0000	46656	3.302	1.55630
37	1369	6.0828	50653	3.332	1.56820
38	1444	6.1644	54872	3.362	1.57978
39	1521	6.2450	59319	3.391	1.59106
40	1600	6.3246	64000	3.420	1.60216
41	1681	6.4031	68921	3.448	1.61278
42	1764	6.4807	74088	3.476	1.62325
43	1849	6.5574	79507	3.503	1.63347
44	1936	6.6332	85184	3.530	1.64345
45	2025	6.7082	91125	3.557	1.65321
46	2116	6.7823	97336	3.583	1.66276
47	2209	6.8557	103823	3.609	1.67210
48	2304	6.9282	110592	3.634	1.68124
49	2401	7.0000	117649	3.659	1.69020
50	2500	7.0711	125000	3.684	1.69897
51	2601	7.1414	132651	3.708	1.70757
52	2704	7.2111	140608	3.733	1.71600
53	2809	7.2801	148877	3.756	1.72428
54	2916	7.3485	157464	3.780	1.73239
55	3025	7.4162	166375	3.803	1.74036
56	3136	7.4833	175616	3.826	1.74819
57	3249	7.5498	185193	3.849	1.75587
58	3364	7.6158	195112	3.871	1.76343
59	3481	7.6811	205379	3.893	1.77085

<i>Number</i>	<i>Square</i>	<i>Square root</i>	<i>Cube</i>	<i>Cube root</i>	<i>Logarithm</i>
60	3600	7.7460	216000	3.915	1.77815
61	3721	7.8102	226981	3.936	1.78533
62	3844	7.8740	238328	3.958	1.79239
63	3969	7.9373	250047	3.979	1.79934
64	4096	8.0000	262144	4.000	1.80618
65	4225	8.0623	274625	4.021	1.81291
66	4356	8.1240	287496	4.041	1.81954
67	4489	8.1854	300763	4.062	1.82607
68	4624	8.2462	314432	4.082	1.83251
69	4761	8.3066	328509	4.102	1.83885
70	4900	8.3666	343000	4.121	1.84510
71	5041	8.4261	357911	4.141	1.85126
72	5184	8.4853	373248	4.160	1.85733
73	5329	8.5540	389017	4.179	1.86332
74	5476	8.6023	405224	4.198	1.86923
75	5625	8.6603	421875	4.217	1.87506
76	5776	8.7178	438976	4.236	1.88081
77	5929	8.7750	456533	4.254	1.88649
78	6084	8.8318	474552	4.273	1.89209
79	6241	8.8882	493039	4.291	1.89763
80	6400	8.9443	512000	4.309	1.90309
81	6561	9.0000	531441	4.327	1.90849
82	6724	9.0554	551368	4.344	1.91381
83	6889	9.1104	571787	4.362	1.91908
84	7056	9.1652	592704	4.380	1.92428
85	7225	9.2195	614125	4.397	1.92942
86	7396	9.2736	636056	4.414	1.93450
87	7569	9.3274	658503	4.431	1.93952
88	7744	9.3808	681472	4.448	1.94448
89	7921	9.4340	704969	4.465	1.94939
90	8100	9.4868	729000	4.481	1.95424
91	8281	9.5394	753571	4.498	1.95904
92	8464	9.5917	778688	4.514	1.96379
93	8649	9.6437	804357	4.531	1.96848
94	8836	9.6954	830584	4.547	1.97313
95	9025	9.7468	857375	4.563	1.97772
96	9216	9.7980	884736	4.579	1.98227
97	9409	9.8489	912673	4.595	1.98677
98	9604	9.8995	941192	4.610	1.99123
99	9801	0.9499	970299	4.626	1.99564
100	10000	10.0000	1000000	4.642	2.00000
0.1	0.01	0.3162	0.001	0.4641	1.00000
0.01	0.0001	0.1	0.000001	0.2154	2.00000
0.001	0.000001	0.03162	0.000000001	0.1	3.00000

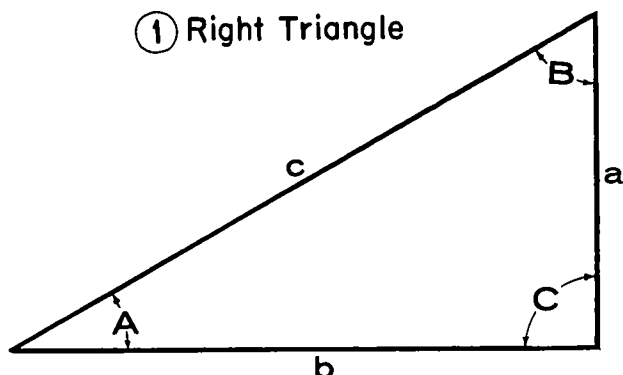
7-50. Decimal Equivalents

<i>Inches</i>		<i>Inches</i>	<i>Millimeters</i>		
1/8	1/16	1/64	0.015625	0.397	
		1/32	-----	.03125	.794
		3/64	-----	.046875	1.191
		5/64	-----	.0625	1.588
		3/32	-----	.078125	1.984
	1/8	7/64	-----	.09375	2.381
		9/64	-----	.109375	2.778
		5/32	-----	.125	3.175
		11/64	-----	.140625	3.572
			-----	.15625	3.969
		-----	.171875	4.366	

				Inches		Inches	Millimeters
1/4	---	---	---	3/16	-----	.1875	4.763
					13/64	.203125	5.159
				7/32	-----	.21875	5.556
					15/64	.2344375	5.953
						.25	6.350
					17/64	.265625	6.747
				9/32	-----	.28125	7.144
					19/64	.296875	7.541
				5/16	-----	.3125	7.938
					21/64	.328125	8.334
				11/32	-----	.34375	8.731
					23/64	.359375	9.128
				3/8	-----	.375	9.525
					25/64	.390625	9.922
					13/32	.40625	10.319
					27/64	.421875	10.716
1/2	---	---	---	7/16	-----	.4375	11.113
					29/64	.453125	11.509
				15/32	-----	.46875	11.906
					31/64	.484375	12.303
						.5	12.700
					33/64	.515625	13.097
				17/32	-----	.53125	13.494
					35/64	.546875	13.891
				9/16	-----	.5625	14.288
					37/64	.578125	14.684
				19/32	-----	.59375	15.081
					39/64	.609375	15.478
				5/8	-----	.625	15.875
					41/64	.640625	16.272
				21/32	-----	.65625	16.669
					43/64	.671875	17.066
3/4	---	---	---	11/16	-----	.6875	17.463
					45/64	.703125	17.859
				23/32	-----	.71875	18.256
					47/64	.734375	18.653
						.75	19.050
					49/64	.765625	19.447
				25/32	-----	.78125	19.844
					51/64	.796875	20.241
				13/16	-----	.8125	20.638
					53/64	.828125	21.034
				27/32	-----	.84375	21.431
					55/64	.859375	21.828
				7/8	-----	.875	22.225
					57/64	.890625	22.622
				29/32	-----	.90625	23.019
					59/64	.921875	23.416
1	---	---	---	15/16	-----	.9375	23.813
					61/64	.953125	24.209
				31/32	-----	.96875	24.606
					63/64	.984375	25.003
					-----	1.0	25.400

7-51. Trigonometric Solution of Triangles

① Right Triangle



$$\sin A = \frac{a}{c}$$

$$\tan A = \frac{a}{b}$$

$$\sec A = \frac{c}{b}$$

$$\text{Area} = \frac{ab}{2} = \frac{a}{2} \sqrt{c^2 - a^2} = \frac{a^2 \cot A}{2}$$

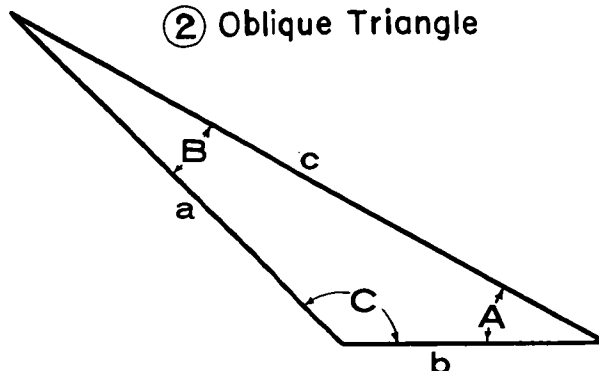
$$= \frac{b^2 \tan A}{2} = \frac{c^2 \sin 2A}{4}$$

$$\cos A = \frac{b}{c}$$

$$\cot A = \frac{b}{a}$$

$$\csc A = \frac{c}{a}$$

② Oblique Triangle



$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$b^2 = a^2 + c^2 - 2ac \cos B$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

$$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$$

Where

$$s = \frac{a + b + c}{2}$$

7-52. Natural Trigonometric Functions

Angle°	Sin	Csc	Tan	Cot	Sec	Cos	Angle°
0	0.000		0.000		1.000	1.000	90
1	.017	57.30	.017	57.29	1.000	1.000	89
2	.035	28.65	.035	28.64	1.001	.999	88
3	.052	19.11	.052	19.08	1.001	.999	87
4	.070	14.34	.070	14.30	1.002	.998	86
5	.087	11.47	.087	11.43	1.004	.996	85
6	.105	9.567	.105	9.514	1.006	.995	84
7	.122	8.206	.123	8.144	1.008	.993	83
8	.139	7.185	.141	7.115	1.010	.990	82
9	.156	6.392	.158	6.314	1.012	.988	81
10	.174	5.759	.176	5.671	1.015	.985	80
11	.191	5.241	.194	5.145	1.019	.982	79
12	.208	4.810	.213	4.705	1.022	.978	78
13	.225	4.445	.231	4.331	1.026	.974	77
14	.242	4.134	.249	4.011	1.031	.970	76
15	.259	3.864	.268	3.732	1.035	.966	75
16	.276	3.628	.287	3.487	1.040	.961	74
17	.292	3.420	.306	3.271	1.046	.956	73
18	.309	3.236	.325	3.078	1.051	.951	72
19	.326	3.072	.344	2.094	1.058	.946	71
20	.342	2.924	.364	2.747	1.064	.940	70
21	.358	2.790	.384	2.605	1.071	.934	69
22	.375	2.669	.404	2.475	1.079	.927	68
23	.391	2.559	.424	2.356	1.086	.921	67

Angle°	Sin	Csc	Tan	Cot	Sec	Coa	Angle°
24	.407	2.459	.445	2.246	1.095	.914	66
25	.423	2.336	.466	2.145	1.103	.906	65
26	.438	2.281	.488	2.050	1.113	.899	64
27	.454	2.203	.510	1.963	1.122	.891	63
28	.469	2.130	.532	1.881	1.133	.883	62
29	.485	2.063	.554	1.804	1.143	.875	61
30	.500	2.000	.577	1.732	1.155	.866	60
31	.515	1.942	.601	1.664	1.167	.857	59
32	.530	1.887	.625	1.600	1.179	.848	58
33	.545	1.836	.649	1.540	1.192	.839	57
34	.559	1.788	.675	1.483	1.206	.829	56
35	.574	1.743	.700	1.428	1.221	.819	55
36	.588	1.701	.727	1.376	1.236	.809	54
37	.602	1.662	.754	1.327	1.252	.799	53
38	.616	1.624	.781	1.280	1.269	.788	52
39	.629	1.589	.810	1.235	1.287	.777	51
40	.643	1.556	.839	1.192	1.305	.766	50
41	.656	1.542	.869	1.150	1.325	.755	49
42	.669	1.494	.900	1.111	1.346	.743	48
43	.682	1.466	.933	1.072	1.367	.731	47
44	.695	1.440	.966	1.036	1.390	.719	46
45	.707	1.414	1.000	1.000	1.414	.707	45

7-53. Computing Guy Stress For Lifting

To compute the stress, or tension, that should be placed upon a guy, the horizontal and vertical distance relationships for upright poles, the weight of the load to be lifted, the weight of the pole, the horizontal distance from base of pole to the guy anchor, and the perpendicular distance from the base of pole

to the guy must be considered. Relationships for computing stress are shown in figure 7-7; 1 illustrates tension or pull (P) for an upright pole when there are known relationships between height of the pole (H) and the ground distance from base of the pole to the guy anchor, and 2 shows how to compute guy stress when the pole is inclined.

Section XIV. TIME, TIDE, AND LIGHT

7-54. Time and Light

a. Designating Time and Date.

(1) *Time*. Expressed in a group of four digits, ranging from 0000 to 2400. The first two digits are the hours after midnight; the remaining two indicate minutes past the hour. Where the hour can be expressed as a single digit, it is preceded by zero; for example, 0625 for 6:25 a.m.

(2) *Date*. Day, month, and year expressed in that order—except when necessary to specify a six-digit time group. In a six-digit time group, the first two digits indicate day of month; the next two the hour; the last two, minutes past the hour. For example, 070625 Dec 62 means 6:25 a.m. on 7 Dec 1962. If desired to keep the date secret, dates may be

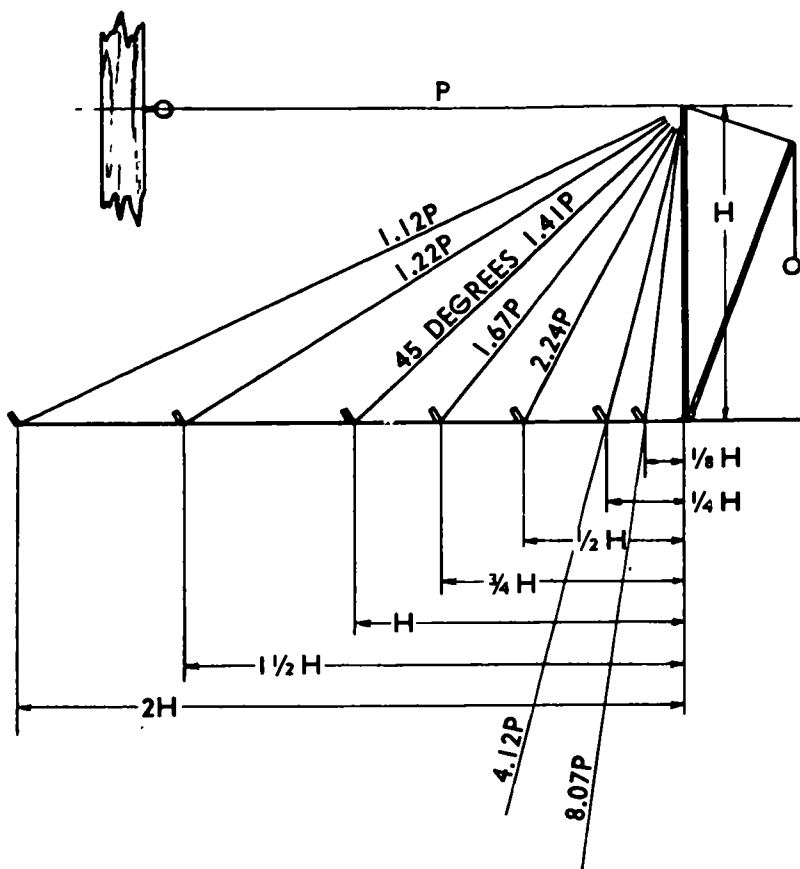
expressed by a letter, such as D plus or minus a numeral in place of the first two digits.

(3) *Greenwich mean time*. Time groups expressing Greenwich mean time are designated by the letter suffix Z immediately following the last digit of the group; for example, 190225Z.

(4) *Expressing natural phenomena*. Indefinite terms, such as first light, last light, daybreak, daylight, darkness, dusk, dawn, are avoided. Definite terms are permissible, such as sunrise, sunset, beginning or end of evening or morning nautical or civil twilight.

b. Time Zone Chart (fig 7-8).

(1) The earth averages one rotation on its axis every 24 hours. This causes in the same period an apparent travel of the sun



TENSION

$$t = \frac{wd}{y}$$

WHERE

y = PERPENDICULAR DISTANCE FROM
BASE OF POLE TO REAR GUY

w = WEIGHT OF LOAD + $\frac{1}{2}$ WEIGHT OF
POLE

d = DISTANCE FROM GUY ANCHOR
TO BASE OF POLE

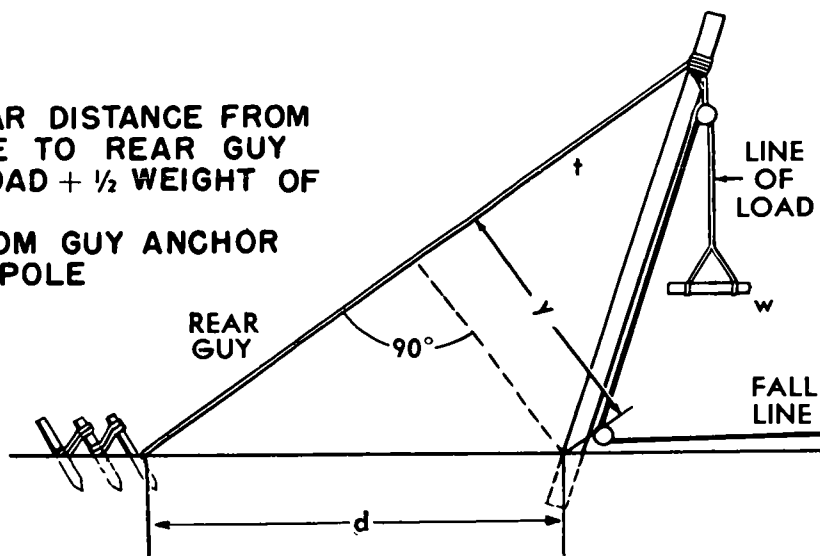


Figure 7-7. Computing guy stress.



across 360° of longitude. Therefore, the surface of the earth is divided into 24 zones 15° wide in longitude—each 1 hour in width. The initial zone is the one which has the meridian of Greenwich running through the middle of it, and the meridians 7½° east of Greenwich and 7½° west of Greenwich marking its eastern and western limits. It is called the “zero zone” because the difference between the standard time of this zone and Greenwich mean time is zero. Each of the zones in turn is designated by a number representing the number of hours by which the standard time of the zone differs from Greenwich mean time. The zones lying in east longitude from the zero zone are numbered in sequence from 1 to 12, and are called minus zones because, in each of them, the zone number must be subtracted from the standard time in order to obtain the Greenwich mean time. The zones lying in west longitude from the zero zones are numbered in sequence from 1 to 12, and are called plus zones because, in each of these zones, the zone number must be added to the standard time in order to obtain the Greenwich mean time. The time kept in any zone is the standard time of its central meridian. The twelfth zone is divided medially by the 180° meridian (the line separating the meridians of east longitude from the meridians of west longitude), and the terms “minus” and “plus” are used in the halves of this zone which lie in the east longitude and west longitude, respectively.

(2) *Use of suffixes.* The suffix letter used after a four- or six-digit time group indicates the number of hours by which the time expressed differs from Greenwich mean time at the same instant. For example, Norfolk, Va., is located in the fifth time zone west of Greenwich. For local mean time, the suffix letter would be R.

(3) *Converting time from zone to zone.* The number in the time zone indicates the number of hours or fraction thereof that local time differs from Greenwich mean time. The time zones extend east and west from Greenwich to the 180th meridian. To transpose Greenwich mean time to local time, add the zone number if the zone is east of the prime

meridian; subtract it if it is west of the prime meridian. Time conversion for any zone is shown in figure 7-9.

7-55. Tides, Sunlight, and Moonlight

a. *Chart.* Figure 7-10 shows the type of chart which is issued for each major operation or operational area. These charts are prepared by the Joint Intelligence Study Publishing Board and appear in JANIS (Joint Army-Navy Intelligence Study).

b. *Area Covered.* Astronomical data are for sea level and do not vary more than 5 minutes over a radius of 60 miles (97 kilometers).

c. *Time Used for the Time Meridian Indicated in the Heading.* When another time meridian is used in the field, the figures representing hours on the left of the large diagram are changed to conform to the new time. If the time meridian to be used is in a zone number east of the one shown on the diagram, the number is increased by 1 hour for each 15°; if west, the number is decreased by 1 hour for each 15°.

d. *Dates.* In the upper diagram of figure 7-9, each day from midnight to midnight is represented by a space between two lines. In the lower diagram, the days are represented by vertical lines covering the period from noon of one day to noon of the next. The dates at the bottom of the diagram differ from those at the top because the dates change in passing through midnight.

e. *Tides.* Times of the tides are shown by curves in the lower diagram. By noting the sequence of the tides during the day, the height of any particular tide can be found by consulting the diagram.

f. *Twilight* (fig. 7-11).

(1) Twilights are the periods of solar illumination before sunrise and after sunset. Both morning and evening twilights are divided into three periods: astronomical, nautical, and civil.

(a) *Astronomical.* Offers meager light, if any; for military purposes, considered period of darkness.

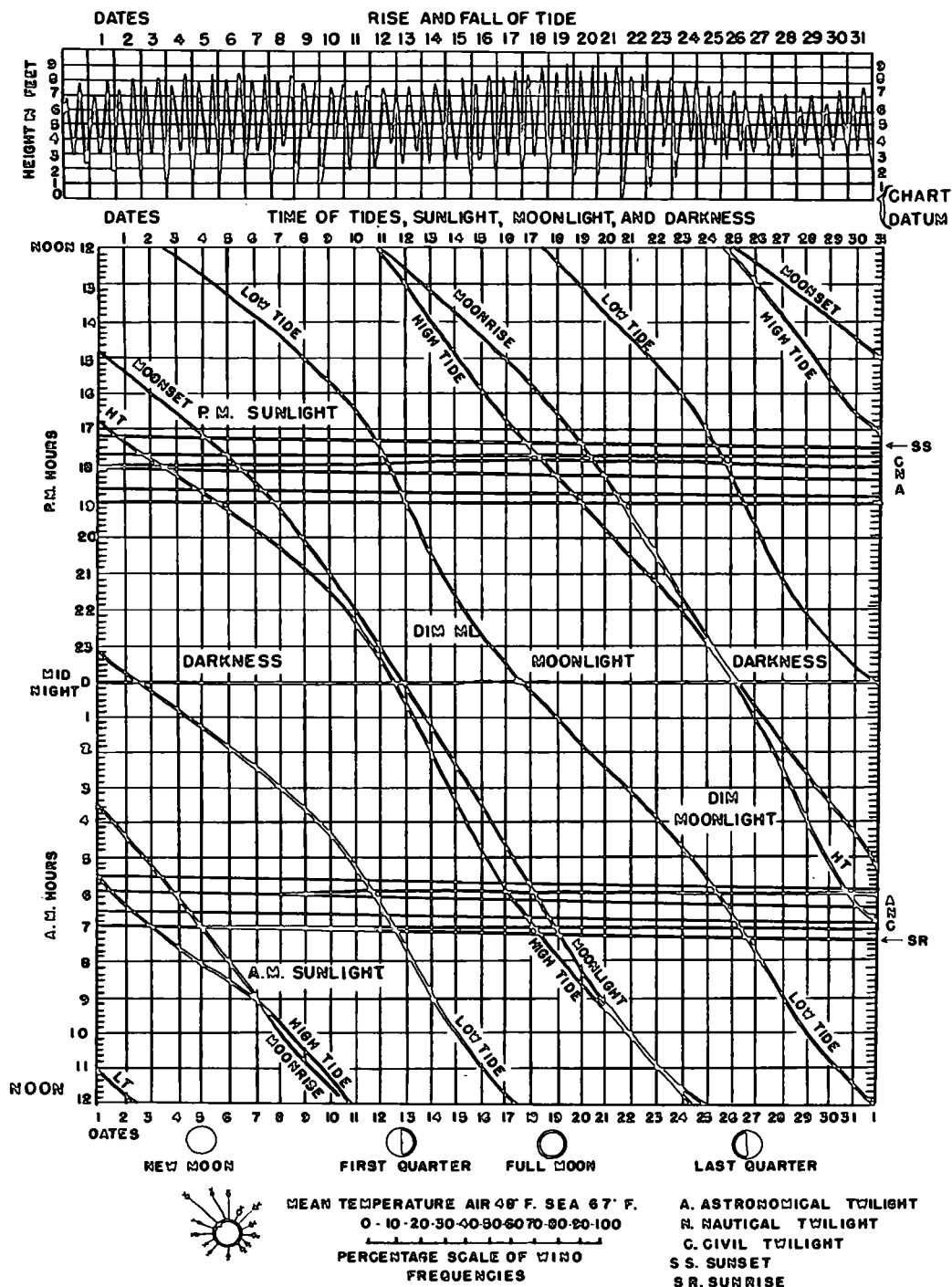
KAGOSHIMA - WAN, KYUSHU *

DECEMBER 1945

LAT 31° 30' N., LONG 130° 40' E.

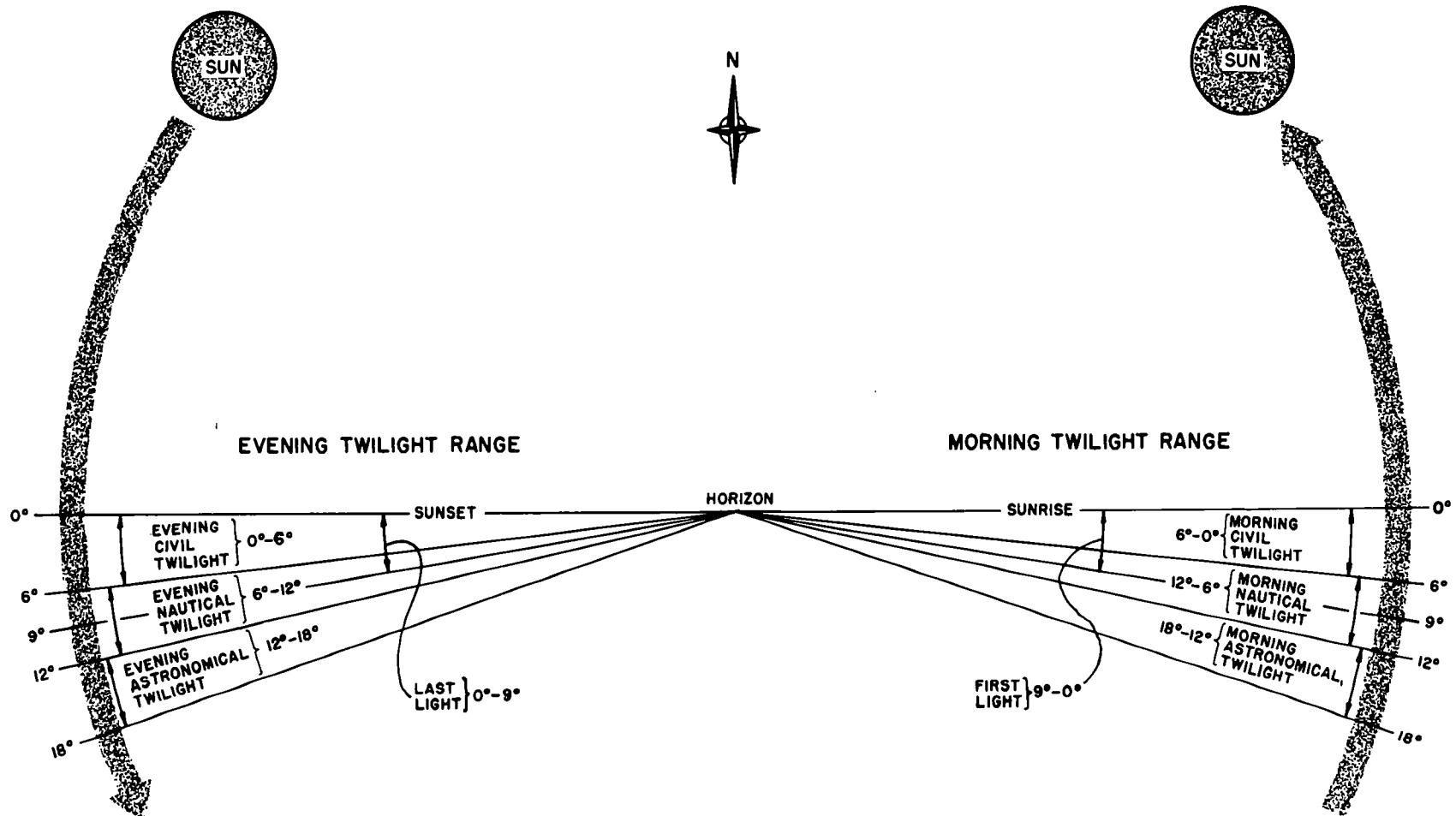
TIME MERIDIAN: 135° E.

SUNLIGHT AND MOONLIGHT DATA COMPUTED FOR LAT 31° 30' N., LONG 130° 40' E.



* THIS DIAGRAM, WITH THE CHANGES INDICATED, IS ALSO APPLICABLE TO THE FOLLOWING PLACES: TOMARI URA — ADD 10 MINUTES TO TIMES OF HIGH AND LOW TIDES, SUBTRACT 1/2 FOOT FROM HEIGHTS OF HIGH TIDES.
ODOMARI-WAN — SUBTRACT 25 MINUTES FROM TIMES OF HIGH AND LOW TIDES, SUBTRACT 1 FOOT FROM HEIGHTS OF HIGH TIDES.

Figure 7-10. Sample diagram of tides, sunlight, and moonlight.



NOTE - Degrees refer to center of sun below horizon.

Figure 7-11. Twilight factors.

(b) *Nautical*. Provides enough light to carry on most types of ground movement without difficulty. Visibility limited to 400 yards (366 meters) or less.

(c) *Civil*. Offers enough light to carry on normal day activities.

(2) Except for high latitudes, durations of astronomical, nautical, and civil twilights may be considered equal.

g. Moonlight. For astronomical twilight and solar darkness, periods of moonlight and solar darkness are shown on the lower diagram of figure 7-10. During the period of moonlight, the intensity of light varies between the brightness of the full moon at zenith and about one-third of this value. During the period of dim moonlight, the intensity varies from about one-third

to one-tenth of the brightness of the full moon at zenith.

h. Moon's Phases. In figure 7-10 the phases of the moon are shown below the days on which they occur.

i. Effect of Weather on Light. Smog, fog, clouds, refraction, reflection, and precipitation affect the degree of illumination. These factors can be included in the calculations by means of experience tables compiled in the area and from meteorological forecasts for the area.

7-56. Hours of Daylight

[Time between sunrise and sunset. It is light for approximately 30 minutes before sunrise and after sunset. For latitude south, subtract figure given from 24]

Latitude North	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0° ----	12	12	12	12	12	12	12	12	12	12	12	12
10° ----	12	12	12	12	13	13	13	12	12	12	12	12
20° ----	11	12	12	13	13	13	13	13	12	12	11	11
30° ----	10	11	12	13	14	14	14	13	12	11	11	10
40° ----	10	11	12	13	14	15	15	14	12	11	10	9
50° ----	9	10	12	14	15	16	16	14	12	11	9	8
60° ----	7	9	12	15	17	19	18	16	12	10	9	6
70° ----	0	7	12	16	23	24	24	18	12	9	4	0
80° ----	0	0	12	24	24	24	24	24	12	5	0	0

7-57. Calendar 1900-1999

a. Calendar.

Key letter ¹

Year

T	1900		
U	1901	1929	1957
V	1902	1930	1958
W	1903	1931	1959
XY	1904	1932	1960
Z	1905	1933	1961
T	1906	1934	1962
U	1907	1935	1963
VW	1908	1936	1964
X	1909	1937	1965
Y	1910	1938	1966
Z	1911	1939	1967
TU	1912	1940	1968
V	1913	1941	1969
W	1914	1942	1970
X	1915	1943	1971
YZ	1916	1944	1972
T	1917	1945	1973
U	1918	1946	1974
V	1919	1947	1975
			1985
			1986
			1987
			1988
			1989
			1990
			1991
			1992
			1993
			1994
			1995
			1996
			1997
			1998
			1999

Key letter¹

	Year		
WX	1920	1948	1976
Y	1921	1949	1977
Z	1922	1950	1978
T	1923	1951	1979
UV	1924	1952	1980
W	1925	1953	1981
X	1926	1954	1982
Y	1927	1955	1983
ZT	1928	1956	1984

¹ Two letters together are shown for leap years. The first is to be used for January and February, the second for other months.

Month	Key letter						
January, October	Z	Y	X	W	V	U	T
February, March, November	W	V	U	T	Z	Y	X
April, July	T	Z	Y	X	W	V	U
May	Y	X	W	V	U	T	Z
June	V	U	T	Z	Y	X	W
August	X	W	V	U	T	Z	Y
September, December	U	T	Z	Y	X	W	V

Day	Day of week										
1	8	15	22	29	Sun	Sat	Fri	Thurs	Wed	Tues	Mon
2	9	16	23	30	Mon	Sun	Sat	Fri	Thurs	Wed	Tues
3	10	17	24	31	Tues	Mon	Sun	Sat	Fri	Thurs	Wed
4	11	18	25	--	Wed	Tues	Mon	Sun	Sat	Fri	Thurs
5	12	19	26	--	Thurs	Wed	Tues	Mon	Sun	Sat	Fri
6	13	20	27	--	Fri	Thurs	Wed	Tues	Mon	Sun	Sat
7	14	21	28	--	Sat	Fri	Thurs	Wed	Tues	Mon	Sun

b. Examples of Use.

(1) Given March 6, 1962, find the day of the week. Opposite the year 1962 is the key letter T. Opposite the month of March, the key letter T appears in the fourth column from the left. Under this key letter, opposite the 6th day, Tuesday is found.

(2) Given Saturday, November __, 1962, find the possible days of the month that Saturday falls upon. Opposite the year 1962 is the key letter T. Opposite the month of November, the key letter T appears in the fourth column from the left. Under the key letter, opposite Saturday, the numbers 3, 10, 17 and 24 are the possible days for November.

(3) Given Tuesday, _____ 6, 1963, find the possible months in which this combination could occur. Opposite 1963, the key letter U is found. Opposite the 6th day, Tuesday appears in the 4th "Day of week" column. Above the column, the key letter U is found opposite August.

(4) Given Monday, February 29, ____, find the possible year(s). Opposite the 29th day, Monday appears in the last column. Above this column, the key letter X is found opposite February. Since February is shown as having 29 days, it must be leap year, which means that the first key letter of a 2-letter group must be used. For the key letter X, the possible years are 1904, 1932, 1960, and 1988.

Section XV. TERRAIN FACTORS**7-58. Gradient**

Gradient, or percent of any slope is the vertical rise divided by the horizontal distance times 100. This information is sometimes needed by operators in the field, and can be

determined from observations on the spot or from a map. These methods are outlined and explained below. When possible, both methods should be used, so that one may serve as a check on the other.

a. Field Method. By use of the Abney hand level or engineer clinometer, the percent slope of a hill or road can be read directly. The level of clinometer is held to the eye and the index arm is moved until the bubble is centered and the observer is looking at a height equal to his line of sight above the top of the slope being measured. The percent of slope may then be read directly from the graduated arc.

b. Map Method. Measure the horizontal distance in feet on the map between your location and top of the slope per map scale. Then determine the difference in elevation between these two points using the contour interval and lines of the map. Use the following formula to obtain gradient in percent.

$$\frac{a}{b} \times 100 = \text{percent of slope.}$$

Where

a = change in elevation in feet

b = horizontal distance in feet between the two points

7-59. Maps

This paragraph provides information and guidance for all personnel in the use of military maps. The readers should refer to FM 21-26, FM 41-30, and TM 21-31 for more detailed information on map reading.

a. Marginal Information. All information concerning a particular map and its use is located in the margin of that map sheet. Because not all maps are alike, it is usually necessary to examine the marginal data before using a map. The following items are of critical importance:

(1) *Grid reference box.* Instructions for using grid references on the map.

(2) *The legend.* Identifies the topographic symbols used on the map.

(3) *Declination diagram.* Indicates the relationship of map features to grid, true, and magnetic north.

(4) *Contour interval note.* Indicates the vertical distance between contour lines on the map.

(5) *Scale note.* Indicates the scale of the map sheet.

b. Map Orientation. Maps may be oriented either by use of a compass or by terrain recognition. The compass method is best if a compass is available. Where well-defined terrain features are evident, the map may be oriented by terrain recognition.

(1) *Compass method.* Place the map sheet on a flat surface. Open the compass and place it flat on the map with the cover pointing in the direction of grid north and the straight-edge parallel to a grid line. Rotate the map and compass, as one, until the magnetic declination (shown on the declination diagram) is reproduced on the face of the compass. The angle of magnetic declination will be formed between the black index line on the glass cover and the luminous arrow of the compass. The map is now exactly oriented to the surrounding ground.

(2) *Terrain recognition method.* This is a method of matching the local terrain features to the same features shown on the map. This method may be aided by orienting the map approximately to north or south by use of one of the expedient direction-finding techniques discussed in subsequent paragraphs.

c. Map Grid System. The grid system is used for locating or referencing the location of points. It consists of two sets of equally spaced parallel lines at right angles to each other, forming grid squares of a standard size. The proper method of using the grid system is found in the grid reference box located in the margin of the map.

d. Scale and Horizontal Distance. It is expressed as the ratio of a distance on the map to the corresponding distance on the ground measured in the same units (feet, kilometers, etc.). This ratio of representative fraction is expressed as one unit of measure on the map to X units of measure on the ground.

$$\text{Example. } 1:500,000 \text{ or } \frac{1}{50,000}$$

Distances can be measured directly on the map using the bar scale located in the margin of the map. The map distance can also be

obtained by measuring a distance and then multiplying that distance by the denominator of a representative fraction; this results in a ground distance in the same unit of measure as was used to measure the map distance.

e. Elevation. Elevation and relief are shown on a topographic map by the use of contour lines. A contour line is an imaginary line in the ground along which all points are the same elevation. Contour lines indicate vertical distance above mean sea level. The vertical distance between contour lines is the contour interval. The vertical distance is constant throughout the area of the map and is found in the marginal data. On the map itself, index contour lines, which are heavier drawn lines than the regular contours, will be broken and the elevation of that index contour line given.

f. Horizontal Direction. Horizontal direction is expressed as a clockwise angle called an azimuth, from either true, magnetic, or grid north. These three kinds of direction are defined below. The relationship between these north directions, and any annual changes to them is found in the declination diagram.

(1) *True north.* A line from any position on the earth's surface to the north pole. All lines of longitude are true north lines. True north is symbolized by a star.

(2) *Magnetic north.* The north that is established by the compass. Magnetic north is symbolized by half hours. Azimuths read directly with a compass are magnetic azimuths and must be corrected to grid north before using that azimuth on the map itself.

(3) *Grid north.* The north that is established by the grid lines on the map. Grid north is symbolized by the letters GN.

g. Expedient Direction-Finding Techniques.

(1) *Daytime.* Use of a watch set on standard time.

(a) *Northern hemisphere.* The hour hand on the watch should be pointed at a direction on the horizon directly below the sun. A line bisecting the smallest angle between the hour hand and 12 o'clock points south.

(b) *Southern hemisphere.* Point the 12 o'clock position on the watch in a direction

which is directly below the sun. A line bisecting the smallest angle between the hour hand and 12 o'clock points north.

(c) *Limitations.* Use of the watch method should be restricted to the north and south temperate zones and the hours between 0700 and 1700.

(2) *Nighttime—use of stars.*

(a) *Northern hemisphere.* Use of the north star (polaris). The two pointer stars which form the side of the cup farthest from the handle of the big dipper are in line with the north star, which is located above the north pole. The distance from the north star to the nearest pointer star is approximately five times the distance between the pointer stars.

(b) *Southern hemisphere.* The Southern Cross, composed of four stars, is used for direction determination. A point above the South Pole is located on an extension of the long axis, four and one-half times the length of that axis, in the direction of the longer part of that axis.

h. Intersection. The process of locating an unknown point by successively occupying two known positions and sighting on the unknown point. If a compass is available, shoot azimuth to the unknown point from both known locations and plot these lines on the map. The unknown point is located at their point of intersection. Care must be taken in plotting compass azimuths to assure that the magnetic azimuths are converted to grid azimuths before plotting. If a compass is not available, the straightedge method may be used.

(1) *Straightedge method.* Orient the map and place it on the ground. Place a straightedge on the map and sight along it from your known location on the map to the unknown point. Repeat this process at the other point. The unknown point is located by the intersection of these lines.

(2) *Resection.* The method of determining the user's location by sighting on two known features that can be located on the map. The previous instructions are simply reversed. Your location is at the point where the lines intersect.



APPENDIX A

REFERENCES

A-1. Army Regulations

55-11	Agreements Between Army and Air Force.
55-26	Transportation Movements.
55-31	Policy Governing Passenger Accommodations Within, To, From or Outside the Continental United States.
55-41	MSTS Passenger Documentation and Traffic Information.
55-53	Transportation Requests.
55-55	Transportation of Radioactive and Fissile Materials Other than Weapons.
55-71	Transportation of Personal Property and Related Services.
55-80	Highways for National Defense.
55-107	Policy Governing Transportation of Passengers Aboard Vessels of Military Sea Transportation Service.
55-113	Movement of Units Within Continental United States.
55-125	Troop Train Emergency Supply Points.
55-203	Movement of Nuclear Weapons Components and Nuclear Weapons Materiel.
55-255	Railroad Equipment.
55-305	Water Transportation; General Provisions.
55-325	Unit Commander and Ship Transportation Officer Aboard Vessels of Military Sea Transportation Service.
55-355	Military Traffic Management Regulation.
55-445	Debarkation of Troops from Transports.
55-650	Military Railroads.
58-Series	Motor Transportation.
59-8	Air Transportation Space and Capability.
59-22	Requests for Transportation by Other Than Scheduled Flights of Military Air Transport Service.
59-30	Revenue Traffic Transported on Department of Defense Aircraft other than Airlift Service, Industrial Fund (MATS).
59-106	Operation of Air Force Terminals.
59-132	Commercial Air Travel to and from Continental United States.
95-Series	Aviation.
96-50	Air Transportation, Canadian-United States Reciprocal Treaty.
190-5	Motor Vehicle Traffic Supervision.
190-60	Physical Security Standards for Nuclear Weapons.
310-32	Organization and Equipment Authorization Tables; Personnel.
320-5	Dictionary of United States Army Terms.
320-50	Authorized Abbreviations and Brevity Codes.
380-55	Safeguarding Defense Information in Movement of Persons and Things.
385-55	Prevention of Motor Vehicle Accidents.
700-4	Technical Assistance Program.

700-60	Utilization of Automotive Gasoline.
700-65	Nuclear Weapons and Nuclear Weapons Materiel.
701-5	Materiel Management Responsibilities; Federal Supply Classification (FSC) Class Assignments.
705-19	Electrical System in Motor Vehicles.
725-50	Requisitioning, Receipt, and Issue System.
735-35	Supply Procedures for TOE and TDA Units or Activities.
740-20	Preparation of Military Materiel for Shipment.
750-5	Organization, Policies, and Responsibilities for Maintenance Operation.
750-7	Support Maintenance Shops and Missions.
750-27	Repair Cost Estimates and Maintenance Expenditure Limits.

A-2. Special Regulation

55-167-15	Procedures Governing Personal Baggage of Passengers Embarked in MSTs Vessels.
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A-3. Field Manuals

1-100	Army Aviation Utilization.
3-8	Chemical Reference Handbook.
3-12	Operational Aspects of Radiological Defense.
5-36	Route Reconnaissance and Classification.
8-35	Transportation of the Sick and Wounded.
19-2	Military Police Support in the Field Army.
19-3	Military Police Support in the Communications Zone.
19-25	Military Police Traffic Control.
19-40	Enemy Prisoners of War and Civilian Internees.
20-32	Landmine Warfare.
21-5	Military Training Management.
21-6	Techniques of Military Instructions.
21-10	Military Sanitation.
21-11	First Aid for Soldiers.
21-26	Map Reading.
21-30	Military Symbols.
21-31	Topographic Symbols.
21-40	Chemical, Biological, and Nuclear Defense.
21-41	Soldier's Handbook of Defense Against Chemical and Biological Operations and Nuclear Warfare.
21-60	Visual Signals.
21-76	Survival.
24-18	Field Radio Techniques.
27-10	The Law of Land Warfare.
30-16	Technical Intelligence.
31-13	Battle Group Landing Team (Amphibious).
31-70	Basic Cold Weather Manual.
38-1	Logistics, Supply Management.
41-5	Joint Manual of Civil Affairs.
41-10	Civil Affairs Operations.
55-6	Transportation Services in Theaters of Operation.
55-8	Transportation Intelligence.
55-9	Transportation Services and the Transportation Brigade in the Field Army.

55-21	Transportation Railway Supervisory Units.
55-22	Transportation Railway Battalion.
55-35	Motor Transport Operations and Motor Transport Units.
55-45	Aircraft Maintenance Services and Units in the Field Army.
55-51	Transportation Terminal Commands, Theater of Operation.
55-52	Transportation Terminal Battalion and Terminal Service Company.
55-58	Transportation Boat Operations.
57-10	Army Forces in Joint Airborne Operations.
57-35	Airmobile Operations.
60-30	Embarkation and Loading—Amphibious.
101-5	Staff Officers' Field Manual; Staff Organization and Procedure.
101-10-Series	Staff Officers' Field Manual.
101-31-Series	Staff Officers' Field Manual.

A-4. Technical Manuals

1-215	Attitude Instrument Flying.
1-250	Fixed-Wing Flight.
1-260	Rotary-Wing Flight.
3-216	Military Biology and Biological Agents.
3-220	Chemical, Biological, and Radiological (CBR) Decontamination.
5-312	Military Fixed Bridges.
5-330 —	Planning, Site Selection, and Design of Roads, Airfields, and Heliports in the Theater of Operation.
5-337	Paving and Surfacing Operations.
5-366	Planning and Design for Rapid Airfield Construction in the Theater of Operations.
9-273	Lubrication of Ordnance Materiel.
9-500	Data Sheets for Ordnance Type Materiel.
10-1101	Petroleum Handling Equipment and Operations.
10-1619	Quartermaster Materials Handling Equipment.
11-487C-1	Military Standardization Handbook: United States Radar Equipment.
38-250	Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft.
38-750	Army Equipment Record Procedures.
38-750-1	Maintenance Management: Field Command Procedures.
55-200	Railway Operating Rules.
55-201	Operation, Inspection, and Maintenance of Steam Locomotives and Locomotive Cranes.
55-202	Operation and Maintenance of Diesel-Electric Locomotives.
55-203	Maintenance of Railway Cars.
55-206	Railway Train Operations.
55-450-Series	Air Transport of Supplies and Equipment.
55-501	Marine Crewman's Handbook.
55-508	Landing Craft Operator's Handbook.
55-511	Operation of Floating Cranes.
55-513	Military Stevedoring.
55-601	Troop Movement Guide.
57-210	Air Movement of Troops and Equipment.

A-5. Technical Bulletins

PMG 5	Traffic Accident Recording.
TC 7	Safe Transport of Radioactive Materials.
TC 11	Arc Welding on Water-Borne Vessels.
AVN 23-5-1	Equipment Improvement Recommendations Digest.
MED 246	Medical Management of Casualties in Nuclear Warfare.
TB 746-93-2	Painting and Marking of Army Aircraft.
TB 746-93-4	Painting of Vessels.

A-6. Supply Bulletins

1-1	Army Aircraft Flying Hour Factors and Forecast.
10-540	Box Lunches and Troop Train and Motor Convoy Menus.
10-495	Standard "B" Ration for the Armed Forces.
55-35	Classification of Aircraft Time Between Overhaul and Retirement Life Stems.
700-20	Army Adopted Items of Matériel.
725-28	Issues of Supplies and Equipment Regulated Aviation Major Items.

A-7. Department of the Army Pamphlets

39-3	The Effects of Nuclear Weapons.
108-1	Index of Army Films, Transparencies, GTA Charts, and Recordings.
310-1	Military Publications: Index of Administrative Publications.
310-2	Military Publications: Index of Blank Forms.
310-3	Military Publications: Index of Doctrinal, Training, and Organizational Publications.
310-4	Military Publications: Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
310-6	Military Publications: Index of Supply Catalogs and Supply Manuals.
740-1-2	Instructor's Guide for Packaging and Packing Operations—Packing and Carloading.

A-8. Tables of Organization and Equipment

1-256	Headquarters and Headquarters Company, Aviation Battalion.
1-257	Aviation Fixed-Wing Company.
1-258	Aviation Medium Helicopter Company.
55-6	Headquarters and Headquarters Detachment, Transportation Movement Control Center.
55-11	Headquarters and Headquarters Company, Transportation Motor Transport Command.
55-12	Headquarters and Headquarters Detachment, Transportation Motor Transport Group.
55-16	Headquarters and Headquarters Detachment, Transportation Motor Transport Battalion.
55-17	Transportation Light Truck Company.
55-18	Transportation Medium Truck Company.
55-19	Transportation Car Company, Army, Logistical Command, or Airborne Corps.
55-27	Transportation Cargo Carrier Company (Tracked).

- 55-28 Transportation Heavy Truck Company.
- 55-47 Transportation Tactical Carrier Company.
- 55-57 Transportation Light Helicopter Company.
- 55-62 Headquarters and Headquarters Company, Transportation Brigade.
- 55-66 Headquarters and Headquarters Company, Transportation Aircraft Maintenance and Supply General Support Battalion.
- 55-67 Transportation Light-Medium Truck Company.
- 55-87 Transportation Motor Transport Company, Supply and Transport Battalion, Armored Division; or Transportation Motor Transport Company, Supply and Transport Battalion, Infantry Division (Mechanized).
- 55-88 Transportation Motor Transport Company, Supply and Transport Battalion, Infantry Division.
- 55-89 Transportation Aircraft Maintenance Company, Company Maintenance Battalion, Infantry Division.
- 55-97 Transportation Motor Transport Company, Supply and Transport Battalion, Airborne Division.
- 55-99 Transportation Aircraft Maintenance Company, Maintenance Battalion, Airborne Division.
- 55-111 Headquarters and Headquarters Company, Transportation Terminal Command C.
- 55-116 Headquarters and Headquarters Detachment, Transportation Terminal Battalion.
- 55-117 Transportation Terminal Service Company.
- 55-121 Headquarters and Headquarters Company, Transportation Terminal Command B.
- 55-128 Transportation Medium Boat Company.
- 55-129 Transportation Heavy Boat Company.
- 55-131 Headquarters and Headquarters Company, Transportation Terminal Command A.
- 55-138 Transportation Light Amphibian Company.
- 55-139 Transportation Medium Amphibian Company.
- 55-140 Transportation Heavy Amphibian Company.
- 55-147 Transportation Staging Area Company.
- 55-157 Transportation Floating Craft Depot Maintenance Company.
- 55-201 General Headquarters, Transportation Railway Service.
- 55-202 Headquarters and Headquarters Company, Transportation Railway Group.
- 55-225 Transportation Railway Battalion.
- 55-226 Headquarters and Headquarters Company, Transportation Railway Battalion.
- 55-227 Transportation Railway Engineering Company, Transportation Railway Battalion.
- 55-228 Transportation Railway Equipment Maintenance Company, Transportation Railway Battalion.
- 55-229 Transportation Train Operating Company, Transportation Railway Battalion.
- 55-235 Transportation Railway Shop Battalion.
- 55-236 Headquarters and Headquarters Company, Transportation Railway Shop Battalion.
- 55-237 Transportation Erecting and Machine Shop Company.

55-238	Transportation Boiler and Smith Shop Company.
55-247	Transportation Diesel-Electric Locomotive Repair Company.
55-248	Transportation Railway Car Repair Company (General Support).
55-260	Transportation Depot Company.
55-457	Transportation Aircraft Direct Support Company.
55-458	Transportation Aircraft Maintenance General Support Company.
55-500	Transportation Service Organization.

A-9. Forms

a. Department of the Army Forms

55-226	Daily Inspection Report—Locomotives and Locomotive Cranes (S&U, Ft Eustis, Va.).
55-227	Monthly Inspection and Repair Report—Steam Locomotives and Locomotive Cranes (S&U, Ft Eustis, Va.).
55-228	Annual Inspection Repair Report—Steam Locomotives and Locomotive Cranes (S&U, Ft Eustis, Va.).
1248	Road Reconnaissance Report.
1249	Bridge Reconnaissance Report.
1250	Tunnel Reconnaissance Report.
1251	Ford Reconnaissance Report.
1252	Ferry Reconnaissance Report.
2400	Equipment Utilization Record.
2401	Organizational Control Record for Equipment.
2404	Equipment Inspection and Maintenance Worksheet.
2408-1	Equipment Daily or Monthly Log.

b. Department of Defense Forms

518	Accident-Identification Card.
1265	Request for Convoy Clearance.
1336	Monthly Inspection and Repair Report of Locomotives and Locomotive Cranes other than Steam.

c. Standard Forms

46	U.S. Government Motor Vehicle Operator's Identification Card.
91	Operator's Report of Motor Vehicle Accident.

A-10. Supply Manuals

TC 7-, 8-, and 9RC-Series	Cranes, Railway.
TC 7-, 8-, and 9-E-Series	Marine Engines (Various Types). Diesel and Gasoline.
TC 7-, 8-, 9C-Series	Railway Cars (Various Types).
TC 7-, 8-, and 9L-Series	Locomotives.
TC 7-, 8-, and 9-W-Series	Winches and Windlasses.
TC 7-BA-527	Barge, Liquid Cargo, Self-Propelled, Diesel, 6,500 bbl, 182 ft, Design 294A.

A-11. Miscellaneous**a. Commercial Publications.*

1. Association of American Railroads, Pamphlet MD-7, Supplement No. 1, Rules Governing the Loading of Department of Defense Materiel on Open Top Cars, Chicago, Illinois, 1955.

2. Knight, Austin Melvin, Modern Seamanship, 12th edition, New York, D. Van Nostrand Co., 1953.

b. Department of Defense Publication MIL-STD-129C, Marking for Shipment and Storage; Joint Military Standard Transportation and Movement Procedures.

c. Hydrographic Office Publication No. 87, International Code of Signals, Vol. 1, Visual and Sound Signaling.

d. U.S. Coast Guard Publication CG-194, Buoys in Waters of the United States.

e. SEATO Publication, CSTAG 20-27 Military Vehicle Markings.

*Available at Army installation libraries.



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By Order of the Secretary of the Army:

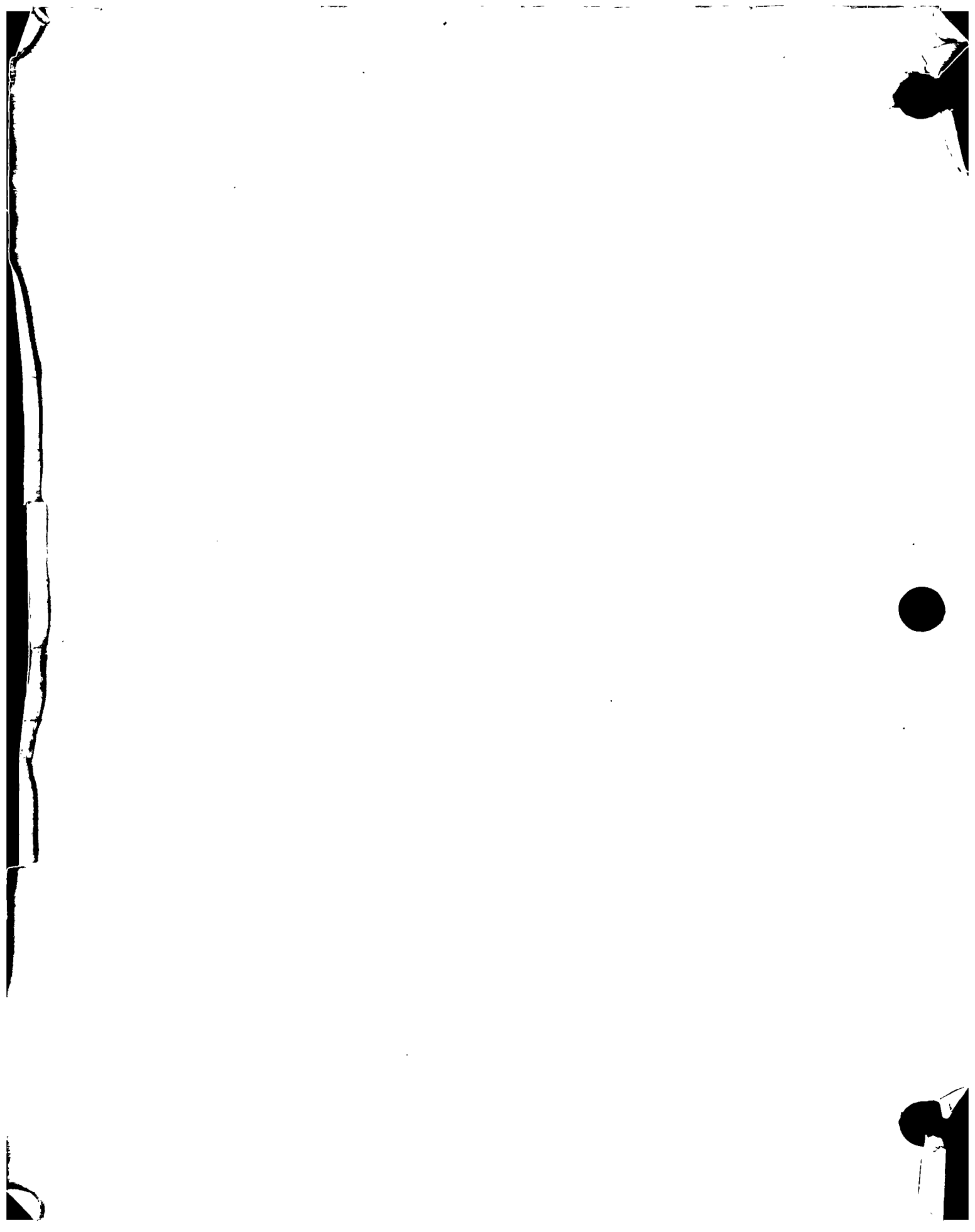
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Distribution:

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CHAPTER 3

MOTOR

Section I. ORGANIZATION

3-1. Organization

Unit	TOE	Mission	Assignment	Capability
Headquarters and headquarters company, transportation motor transport command.	55-11	To command, plan, supervise, coordinate, and control the activities of transportation highway transport groups and other assigned or attached units required in the movement of cargo or personnel by highway transport, particularly in a continuous intersectional or other line-haul operation.	To an army or to a theater army.	a. Commanding and supervising the activities of three to seven transportation truck groups plus supporting units from appropriate administrative and technical services. b. Providing complete control and direction of highway traffic for all highway users on a given road network or in a specified geographical area when authorized by the appropriate commander and augmented by military police units. c. Assuming informal accountability for all trailer and semitrailer equipment during a relay operation.
Headquarters and headquarters detachment, transportation motor transport group.	55-12	To provide command, staff planning, and control of operations of transportation truck and/or tracked vehicle battalions.	To a field army, corps, or a logistical command. Normally attached to a transportation motor transport command.	Commanding, planning, and supervising the activities of three to seven transportation motor transport battalions.
Headquarters and headquarters detachment, transportation motor transport battalion.	55-16	To provide command and supervision of units engaged in all types of motor transport, such as direct support of tactical units, depot and terminal operations, and line hauls.	To a field army, corps, or logistical command. Normally attached to a transportation motor group, TOE 55-12.	a. Provides command and supervision for three to seven transportation companies or any appropriate combination thereof. b. Operates a truck terminal and/or trailer relay system when required. These operations require augmentation from TOE 55-500 and TOE 29-500.
Transportation light truck company.	55-17	To provide transportation for the movement of general cargo and personnel by motor transport.	To a field army, corps, or a logistical command. Normally attached to a headquarters and headquarters detachment,	At full strength, with 45 trucks available making four round trips per day in local hauls or two round trips per day (one per 10-hour shift) in line hauls, a light truck

Unit	TOE	Mission	Assignment	Capability
Transportation medium truck company.	55-18	To provide transportation for the movement of general cargo, bulk petroleum products, and refrigerated cargo by motor transport.	transportation motor transport battalion, TOE 55-16.	company can transport the following: a. When equipped with 2½-ton trucks: (1) For local hauls—720 short tons of cargo (4 tons per truck) based on 75-percent availability of vehicles and 4 trips daily on highway or 3,600 passengers (20 passengers per truck) on or off highway. (2) For line hauls—360 short tons of cargo (4 tons per truck) based on 75-percent availability of vehicles and 2 trips daily on highway or 1,440 passengers (16 passengers per truck) on or off highway. (3) 112.5 short tons of cargo (2½ tons per truck) in one lift off highway. b. When equipped with 5-ton trucks: (1) Local hauls—1,080 short tons of cargo (6 tons per truck) based on 75-percent availability of vehicles and 4 trips daily on or off highway or 3,600 passengers (20 passengers per truck) on or off highway. (2) Line hauls—540 short tons of cargo (6 tons per truck) based on 75-percent availability of vehicles and 2 trips daily on highway or 1,620 passengers (18 passengers per truck) on or off highway. (3) 180 short tons of cargo (4 tons per truck) in one lift off highway. a. At full strength, with 45 semi-trailer combinations available making four round trips per day in local hauls or two round trips per day (one per 10-hour shift) in line hauls, a medium truck company can transport the following:

Transportation car
company.

55-19

To transport personnel and
light cargo by motor
vehicles.

a. To a field army or
logistical command. Nor-
mally attached to head-
quarters and headquarters
detachment, transportation
motor transport battalion,
TOE 55-16, may also be
assigned to independent
corps force or to a corps.
b. To an airborne corps.

(1) When equipped with 12-ton
cargo semitrailers:

(a) Local hauls—2,160 short
tons of cargo (12 tons per semi-
trailer) or in an emergency only,
9,000 passengers (50 passengers per
semitrailer).

(b) Line hauls—1,080 short
tons of cargo (12 per semitrailer)
or in an emergency only, 4,500 passen-
gers (50 passengers per semitrailer).

(2) When equipped with 5,000-
gallon petroleum semitrailers:

(a) Local hauls—900,000 gal-
lons.

(b) Line hauls—450,000 gal-
lons.

(3) When equipped with 7½-ton
refrigerator semitrailers carrying 6
tons per vehicle:

(a) Local hauls—1,080 short
tons.

(b) Line hauls—540 short tons.

b. With minor modifications, i.e.,
military desert design tires, this unit
can provide logistical and combat
support in desert areas of the world.

a. Each platoon when equipped with
sedans can transport 75 personnel in
one lift.

b. Each platoon when equipped with
¼-ton trucks and trailers can trans-
port 45 personnel and 2½ tons of
baggage or small-sized supplies or
6¼ tons of small-sized supplies and
cargo, mail, or light commodities in
one lift.

c. Each platoon when equipped with
¾-ton trucks can transport 11¼ tons
of cargo or 120 people in one lift.

d. Each composite platoon composed
of ten ¼-ton trucks and trailers and
ten ¾-ton trucks (designated the air-
borne platoons in the airborne orga-
nization) is capable of transporting
82 personnel and 7½ tons of baggage
or small-sized supplies or 10 tons of

FM 55-15

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Transportation cargo carrier company (tracked).	55-27	To provide transportation for supply distribution in regions where wheeled vehicles cannot operate effectively.	To a division employed in regions where wheeled vehicles cannot operate as effectively. To a corps, field army, or logistical command, as required.	small-sized supplies and cargo, mail or light commodities in one lift. e. All capabilities are computed on a 75-percent availability of vehicles and all vehicles carrying rated capacity. f. When organized for assignment to an airborne corps, the parachute platoon has the capability of being landed by parachute or aircraft. All personnel in this platoon are airborne qualified. At full strength (level 1) this unit is capable of the following: a. With all vehicles available, transporting in one lift 288 short tons of cargo. b. In sustained operations, based on 75-percent vehicle availability, transporting 216 short tons of cargo or, when equipped with tank units, transporting 43,200 gallons of fuel 50 miles forward daily.
Transportation heavy truck company.	55-28	To provide truck transportation for the movement of tanks and other heavy or bulky vehicles and to transport heavy, bulky, or outsized cargo.	To a field army, corps, or a logistical command.	At full strength, operating two 10-hour shifts per day, with 18 tractor trucks and semitrailers available, this unit can: a. For local hauls—transport 2,880 short tons of cargo or tanks or similar vehicles, averaging 40 tons per truck, four round trips daily. b. For line hauls—transport 1,440 short tons of cargo or tanks or similar vehicles, averaging 40 tons per truck, two round trips daily.
Transportation light-medium truck company.	55-67	To provide transportation for the movement of general cargo and personnel by motor transport.	To a field army support command, corps support brigade, or a logistical command. Normally attached to a supply and service battalion, transportation general support	<i>Cargo Personnel</i> a. At full strength, all vehicles available, one-time lift 360 1,700 b. At full strength, 75 percent of vehicles available, one-time lift .. 276 1,300 c. Local haul, 15

battalion, or transport
battalion (DS).

miles forward, two
shift operations, 75 to
80 percent of vehicles
available, 4 trips cargo
and 6 trips personnel -- 1,104 7,800

d. Line haul, 75 miles
forward, two shift op-
erations, 75 to 80 per-
cent of vehicles availa-
ble, 2 trips daily ----- 552 2,600

At full strength (level 1) this unit
has, based on 75-percent vehicle
availability, a capability of trans-
porting:

	Single Lift	Shuttle
Cargo, short tons --	270	360
POL, gallons -----	75,000	75,000

Transportation motor
transport company,
armored or mechanized
division supply and
transport battalion.

55-87

a. To provide transpor-
tation for unit distribution
of all classes of supply ex-
cept class V.

b. To transport the divi-
sion reserve supplies for
which the unit is responsi-
ble.

c. To furnish vehicles
required for displacing di-
vision headquarters and di-
vision administration com-
pany and to supplement
means available to other
elements of the division.

Organic to supply and
transport battalion, ar-
mored division or infan-
try division (mechan-
ized), TOE 29-65.

Transportation motor
transport company,
supply and transport
battalion, infantry
division.

55-88

a. To provide transpor-
tation for unit distribution
of all classes of supply ex-
cept class V.

b. To transport the divi-
sion reserve supplies for
which the unit is responsi-
ble.

c. To furnish vehicles
required for displacing di-
vision headquarters and the
division administration
company and to supplement
means available to other
elements of the division.

Organic to supply and
transport battalion, in-
fantry division, TOE
29-5.

At full strength (level 1) based on
75-percent vehicle availability,
transports in one lift:

a. 270 short tons of general cargo
and 37,500 gallons of POL in one lift.

b. 120 short tons of unit impedi-
menta in shuttle service.

Transportation motor
transport company,
supply and transport
battalion, airborne
division.

55-97

To provide transportation
for unit distribution of
all classes of supply ex-
cept class V.

Organic to supply and
transport battalion, air-
borne division, TOE 29-
45.

a. At full strength, based on 75-
percent vehicle availability, trans-
ports in one lift:

(1) 108 short tons of general
cargo.

(2) 3,600 gallons of POL.

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Team GA, trailer transfer point operations.	55-540	To operate a trailer transfer point, marshalling yard or truck terminal in conjunction with line-haul operations.	To a transportation motor transport command or similar organization responsible for lines of communication (LOC) highway operations.	b. At full strength, this unit is capable of providing transportation for two 10-hour shifts during an around-the-clock operation. Operates in conjunction with a line-haul operation, a trailer transfer point with a maximum capacity of 250 12-ton trailer units in and out per day. The operation includes receiving, segregating, and assembling loaded or empty semitrailers for convoys; maintaining POL dispersing facilities to refuel hauling equipment; and servicing, inspecting, and if required, making emergency repairs to incoming vehicles.
Team GB, highway regulating point.	55-540	To operate highway regulating to coordinate the movement of authorized traffic and to effect changes in truck or convoy routings.	To a logistical command or field army. Normally attached to a headquarters and headquarters detachment, transportation motor transport group.	Performs the following on a 24-hour-per-day basis: a. Reports on convoys and other elements arriving at and clearing the point so that progress may be reported and recorded; adjusts their rate of advance as required. b. Receives, correlates, and disseminates information on forecast or passing traffic; makes reports on current highway conditions and changes as they occur. c. Transmits orders from higher headquarters to passing units or organizations and makes diversions and effects changes in priorities of traffic as directed by the appropriate traffic headquarters or comparable unit. d. Receives and passes to appropriate agency requests for road clearance; checks clearances of passing units.
Team GC, car squad . . .	55-540	To transport passengers, messengers, and a limited amount of cargo by sedan or light truck.	To headquarters and headquarters detachment, transportation motor transport battalion, TOE 55-16, or may operate	At 75-percent vehicle availability, provides the following transport for personnel and light cargo by motor vehicle: a. When equipped with sedans, can

Team GD, bus squad --- 55-450

To transport personnel or litter patients by bus.

separately, under the supervision of an appropriate commander.

To headquarters and headquarters detachment, transportation motor transport battalion, TOE 55-16, or may operate separately under the supervision of an appropriate commander.

transport 30 personnel in one lift.

b. When equipped with ¼-ton trucks with trailers, can transport 22 personnel and 2 tons of baggage or small size supplies, or 4 tons of small size supplies and cargo, mail, or light commodities in one lift.

With 75-percent vehicle availability, provides transport for 166 passengers or 80 litter patients per lift.

Team GE, heavy truck squad. 55-450

To provide truck transportation for the movement of tanks and other heavy or bulky vehicles, and to transport heavy, bulky, and outsized cargo.

To headquarters and headquarters detachment, transportation motor transport battalion, TOE 55-16, or may operate separately under the supervision of an appropriate commander.

At full strength operating two 10-hour shifts, with 75-percent vehicle availability, this team can transport the following:

a. For local hauls: 488 short tons of cargo or tanks or similar vehicles, averaging 40 tons per truck, four round trips daily.

b. For line hauls: 240 short tons of cargo or tanks or similar vehicles, averaging 40 tons per truck, two round trips daily.

c. Returning inoperative wheel and track vehicles by haulaway from forward areas to maintenance shops for repairs.

Team GF, light truck squad. 55-540

To transport cargo and personnel over poor roads or off road by light truck when use of heavier, more economical types of transport vehicles is impractical.

To headquarters and headquarters detachment, transportation motor transport battalion, TOE 55-16, or may operate separately under the supervision of an appropriate commander.

a. At full strength with 75-percent vehicle availability, making four round trips per day in local hauls or two round trips per day (one per 10-hour shift) in line hauls, this team can transport the following when equipped with 2½-ton trucks:

(1) For local hauls: 130 short tons of cargo (4 tons per truck) on highway, or 600 passengers (20 passengers per truck) on or off highway.

(2) For line hauls: 60 short tons of cargo (4 tons per truck) on highway, or 240 passengers (16 passengers per truck) on or off highway.

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Team GG, medium truck squad.	55-540	To transport general cargo bulk petroleum products or refrigerated cargo by medium trucks and trailers.	To headquarters and headquarters detachment, transportation motor transport battalion, TOE 55-16, or may operate separately under the supervision of an appropriate commander.	(3) 18.75 short tons of cargo (2½ tons per truck) in one lift off highway. b. When equipped with 5-ton trucks: (1) Local hauls: 180 short tons of cargo (6 tons per truck) on highway or 600 passengers (20 passengers per truck) on or off highway. (2) Line hauls: 90 short tons of cargo (6 tons per truck) on highway or 270 passengers (18 passengers per truck) on or off highway. (3) In one lift off highway, 30 short tons of cargo (4 tons per truck). With 75-percent vehicle availability at full strength with vehicles making four round trips daily in local hauls or two round trips per day in line hauls (two 10-hour shifts), this team can transport the following: a. When equipped with 12-ton cargo semitrailers: (1) Local hauls: 360 short tons of cargo (12 tons per semitrailer) or, in an emergency only, 1,500 passengers (50 passengers per semitrailer). (2) Line hauls: 180 short tons of cargo, or 750 troops. b. When equipped with 5,000-gallon petroleum semitrailers: (1) Local hauls: 150,000 gallons. (2) Line hauls: 75,000 gallons. c. When equipped with 7½-ton refrigerator semitrailers carrying 6 tons per vehicle: (1) Local hauls: 180 short tons. (2) Line hauls: 90 short tons.
Team GH, driveaway platoon.	55-540	To provide personnel to move vehicles between forward and rear areas by driveaway.	To headquarters and headquarters detachment, transportation motor transport battalion, TOE	a. Moving 45 operable vehicles between forward and rear areas by driveaway. The numbers of vehicles can be increased by use of tow bars

55-16, or may operate separately under the supervision of an appropriate commander.

or by hauling smaller vehicles in cargo compartments of larger vehicles.
b. Providing transportation of general cargo to be delivered along the route of the driveway operation.

Section II. VEHICLES AND EQUIPMENT

3-2. Vehicle Characteristics

Nomenclature	Payload (lb)		Cargo body space (cu ft)	Fuel tank capacity (gal.)	Cruising range (miles)	Fuel consumption (mpg)	Grade-ability	Fording depth (in.)		Crankcase capacity (qt)	Cooling system cap. (qt)
	off highway	on highway						Without kit	With kit		
Automobile, sedan, light		750		20	300	15	36	18		5	18
Automobile, sedan, medium		850		20	250	13	32	32		5	19½
Bus, 37-passenger, 4x2		8,700		75	300	4	17	20		10	36
Carrier, light weapons, ½-ton, 4x4, M274	1,000	1,000	34	8	107	13	60	18		2	
Truck, ambulance, ¼-ton, 4x4, M170	800	1,000		20	300	15	71	17		5½	11½
Truck, ambulance, ¾-ton, 4x4, M43	1,400	1,400		24	215	9	68	42	84	5	17
Truck, pickup, ½-ton, 4x2	1,000	1,300	44	19	190	10	38	24		5	17½
Truck, utility, ¼-ton, 4x4, M38A1 and A1C	800	1,200		17	280	17	69	37½	70	4½	11½
Truck, utility, ¼-ton, 4x4, M151	800	1,200		17	300	18	60	21		5	8
Truck, utility, ½-ton, 4x4, M422 and 422A1	850	1,000		13	225	17	60	21	60	4	
Truck, cargo, ¾-ton, M37 and 37B1	1,500	2,000	146.1	24	225	8	65	42	84	5	17
Truck, cargo, stake, 1½-ton, 4x2	3,140	7,360	385	49	400	9	38	25		5	17½
Truck, cargo, 2½-ton, 6x6, M34	5,000	10,350	389.0	50	350	7	64	30	72	9	22
Truck, cargo, 2½-ton, 6x6, M35	5,000	10,350	442.6	50	300	6	64	30	72	9	22
Truck, cargo, 2½-ton, 6x6, M36 and 36C	5,000	10,000	770.0	50	300	6	64	30	72	9	22
Truck, cargo, 2½-ton, 6x6, M135	5,000	10,000	401.7	56	224	4	60	30	78	11	22
Truck, cargo, 2½-ton, 6x6, M211	5,000	10,000	442.6	56	224	4	60	30	78	11	22
Truck, cargo, 5-ton, 6x6, M41	10,000	15,000	473.3	78	280	4	68	30	78	22	44
Truck, cargo, 5-ton, 6x6, M54	10,000	20,350	506.3	78	214	2.7	50.6	30	78	22	44
Truck, cargo, 5-ton, 6x6, M55	10,000	20,000	761.7	78	214	2.7	65	30	78	22	44
Truck, cargo, 10-ton, 6x6, M125	20,000	35,000	600	110	330	3	60	30	78	22	66
Truck, dump, 2½-ton, 6x6, M59	5,000	10,000	67	50	300	6	63	30	72	9	22
Truck, dump, 2½-ton, 6x6, M215	5,000	10,000	67	56	300	5.4	66	30	80	8¾	22
Truck, dump, 2½-ton, 6x6, M342	5,000	10,000	67	50	350	7	64	40	72	10½	22
Truck, dump, 5-ton, 6x6, M51	10,000	20,000	135	110	480	4.4	70	30	78	22	44
Truck, tank, gasoline, 2½-ton, 6x6, 1,200-gal., M49	5,000	8,000		50	350	7	62	40	72	9	22
Truck, tank, fuel, serv, 2½-ton, 6x6, 1,200-gal., M217	5,000	8,000		56	300	5.4	67	30	80	8¾	22
Truck, tank, water, 2½-ton, 6x6, M50	3,500	8,500		50	350	7	57.5	40	72	9	22
Truck, tank, water, 2½-ton, 6x6, M222	3,500	8,500		56	300	5.4	60	30	72	8¾	22
Truck, tractor, 2½-ton, 6x6, M48	7,000	12,000		50	350	7	40	30	72	9	22
Truck, tractor, 2½-ton, 6x6, M221	7,000	12,000		56	300	5.4	52	30	72	8¾	22

Nomenclature	Payload (lb)		Cargo body space (cu ft)	Fuel tank capacity (gal.)	Cruising range (miles)	Fuel consumption (mpg)	Grade- ability	Fording depth (in.)		Crankcase capacity (qt)	Cooling system cap. (qt)
	off highway	on highway						Without kit	With kit		
Truck, tractor, 2½-ton, 6x6, M275	7,000	12,000	-----	50	350	7	57.5	30	78	9	22
Truck, tractor, 5-ton, 6x6, M52	15,000	25,000	-----	110	300	3	77	30	78	22	44
Truck, tractor, 10-ton, 6x6, M123, C and D	30,000	35,000	-----	166	300	1.8	60	30	78	22	66
Truck, tractor, 12-ton, 6x6, M26A1	-----	60,000	-----	120	120	1	30	56	--	28	56
Truck, van, shop, 2½-ton, 6x6, M109, A1, C and D ..	5,350	5,350	-----	50	350	7	48	30	72	9	22
Truck, van, shop, 2½-ton, 6x6, M220, C and D ..	5,000	7,500	-----	56	300	5.4	66	30	80	8¾	22
Truck, van, shop, 2½-ton, 6x6, M512, C, D, E and G	5,350	5,350	-----	50	300	6	60	30	72	9	22
Truck, van expandible, 2½-ton, 6x6, M292	5,000	5,000	-----	50	350	7	60	30	72	9	22
Truck, wrecker, crane, 2½-ton, 6x6, M108	5,000	5,000	-----	50	300	6	63	40	72	9	22
Truck, wrecker, light, 2½-ton, 6x6, M60	6,000	10,000	-----	50	300	6	63	40	72	9	22
Truck, tractor, wrecker, 5-ton, 6x6, M246	12,000	16,000	-----	78	229	4.4	47	30	78	22	42
Truck, wrecker, med, 5-ton, 6x6, M62	7,000	12,000	-----	78	214	2.7	36	30	78	18	44
Truck, wrecker, med, 5-ton, 6x6, M543	7,000	12,000	-----	133	-----	--	36	30	78	18	44

3-3. Typical Truck Equipment for Motor Transport Units

a. Basic Issue List Item. Equipment listed is typical but subject to change. For exact quantities the latest authorizations must be checked.

b. TOE Material. The issue of this material varies with each type truck. It includes flashlight, MX-991 U; and goggles, M-1944.

c. Special Material.

Chains, tire, pair As required by local weather conditions.

Extinguisher, fire, dry
chemical, 2 1/2-lb. As authorized by AR 385-55

Kit, deepwater fording }
Kit, winterization } When authorized by theater of operations commander.

Items	Truck			
	1/4 T	3/4 T	2 1/2 T	5 T
Bag, tool	1	1	1	1
Bracket, drum, flammable	1	1	1	1
Bracket, tool, pioneer equipment	-	1	-	-
Chain, tow, 7/16 in. × 16 ft	-	-	*1	-
Chain, tow, 5/8 in. × 16 ft	-	-	-	1
Handle, wheel stud nut	1	1	1	1
Hose, tire inflation	-	-	1	1
Jack, 1 1/2-ton capacity	1	-	-	-
Jack, 3-ton capacity	-	1	1	-
Jack, 8-ton capacity	-	-	-	1
Pliers, comb, slip joint, 8 in.	1	1	1	1
Screwdriver, common, heavy duty, 4 in.	-	1	-	-
Screwdriver, common, heavy duty, 6 in.	1	-	1	-
Screwdriver, common, heavy duty, 9 in.	-	-	-	1
Screwdriver, Phillips, No. 1	-	-	1	-
Screwdriver, Phillips, No. 2	-	-	1	-
Screwdriver, Phillips, No. 3	-	1	-	-
Wrench, adjustable, 8-in	1	1	1	1
Wrench, plug, straight bar	1	1	1	1
Wrench, wheel stud nut	1	1	1	1

*Issued on truck with winch.

Section III. OPERATIONS

3-4. Outline of Standing Operating Procedure for Motor Transport Movements (Within Divisions, Logistical Commands, or Higher Echelons)

a. General. Policies and factors involved in movements are—

(1) *Highway regulation.* Purpose, application or scope, responsibilities, methods and procedures for accomplishment.

(2) *Convoy clearance.* Minimum vehicle requirements, convoy symbols, procedures, format for requesting and furnishing clearance, routing, halts, convoy composition, restrictions on tracked, overweight, or oversized vehicles.

(3) *Highway regulation points.* Purpose, basis of establishment, responsibilities and procedures for operations, required records.

(4) *Traffic control.* Responsibilities, relationship to highway regulation, coordination measures effected with provost marshal.

(5) *Return loads.* Policies, methods, and procedures for securing and reporting.

(6) *Convoy commanders.* Appointment,

responsibilities, and functions; relationships with transportation personnel; instructions to be furnished.

(7) *Halts.* Types, policies, procedures, and responsibilities for establishment and conduct of halts; area policing.

(8) *Security.* Responsibilities and methods of conducting defensive measures.

(9) *Records and reports.* Responsibilities and methods for maintenance of required records, reference to reports to be submitted.

(10) *Communications.* Responsibilities and means of communication.

b. Supply Movements.

(1) *Releases.* When required, methods of obtaining, formats, dissemination, actions required.

(2) *Diversions and reconsignments.* Authority to effect diversions with consideration for various command areas, procedures for initiating requests, and execution.

(3) *Records and reports.* Types of records required to be maintained on supply movements, reference to reports to be submitted.

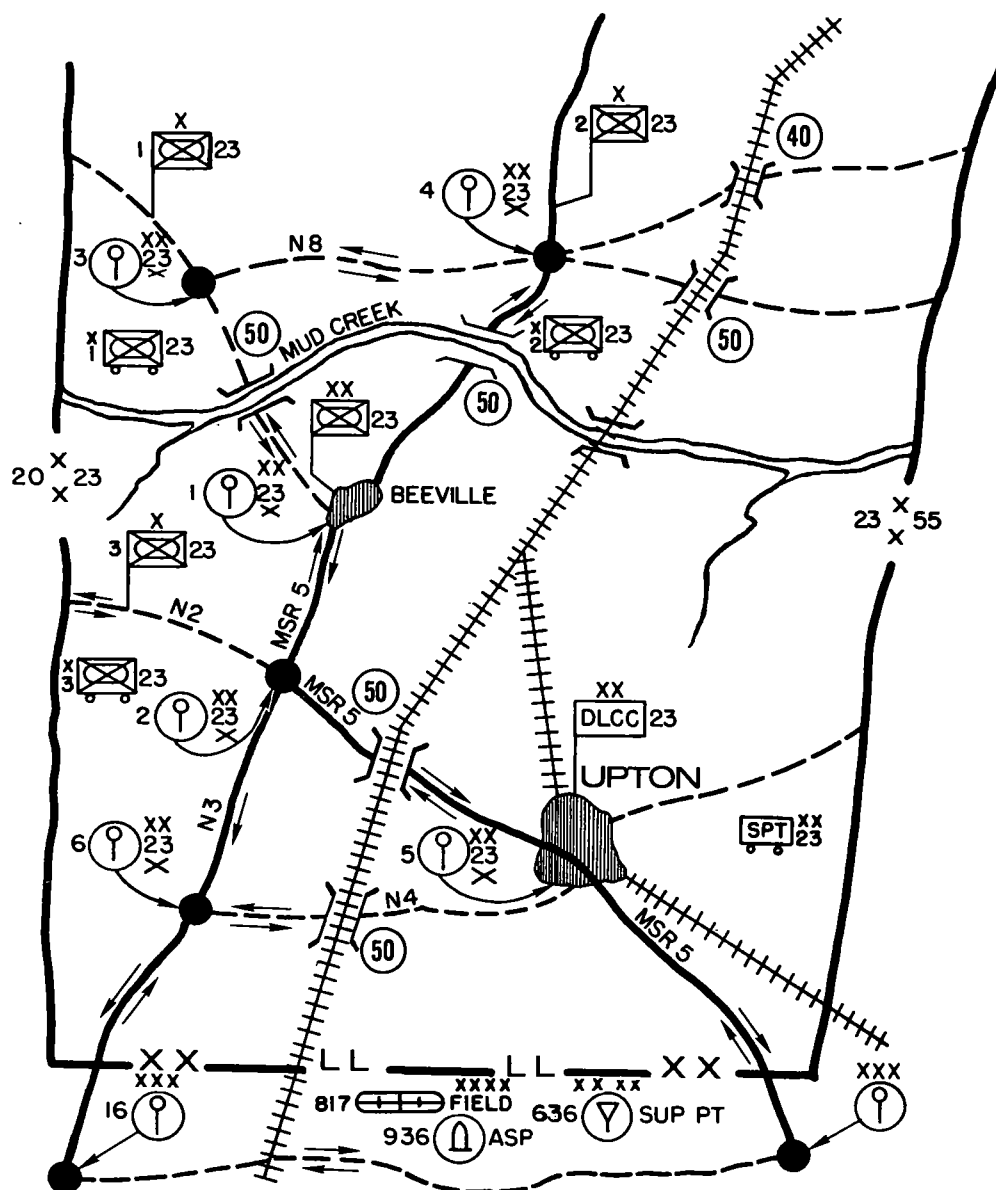


Figure 3-1. Traffic circulation plan.

3-5. Outline of Standing Operating Procedure for Motor Transport Service

a. General. Policies involved in control, operation, and maintenance of facilities, equipment, and installation; command responsibility; technical supervision required and agencies involved.

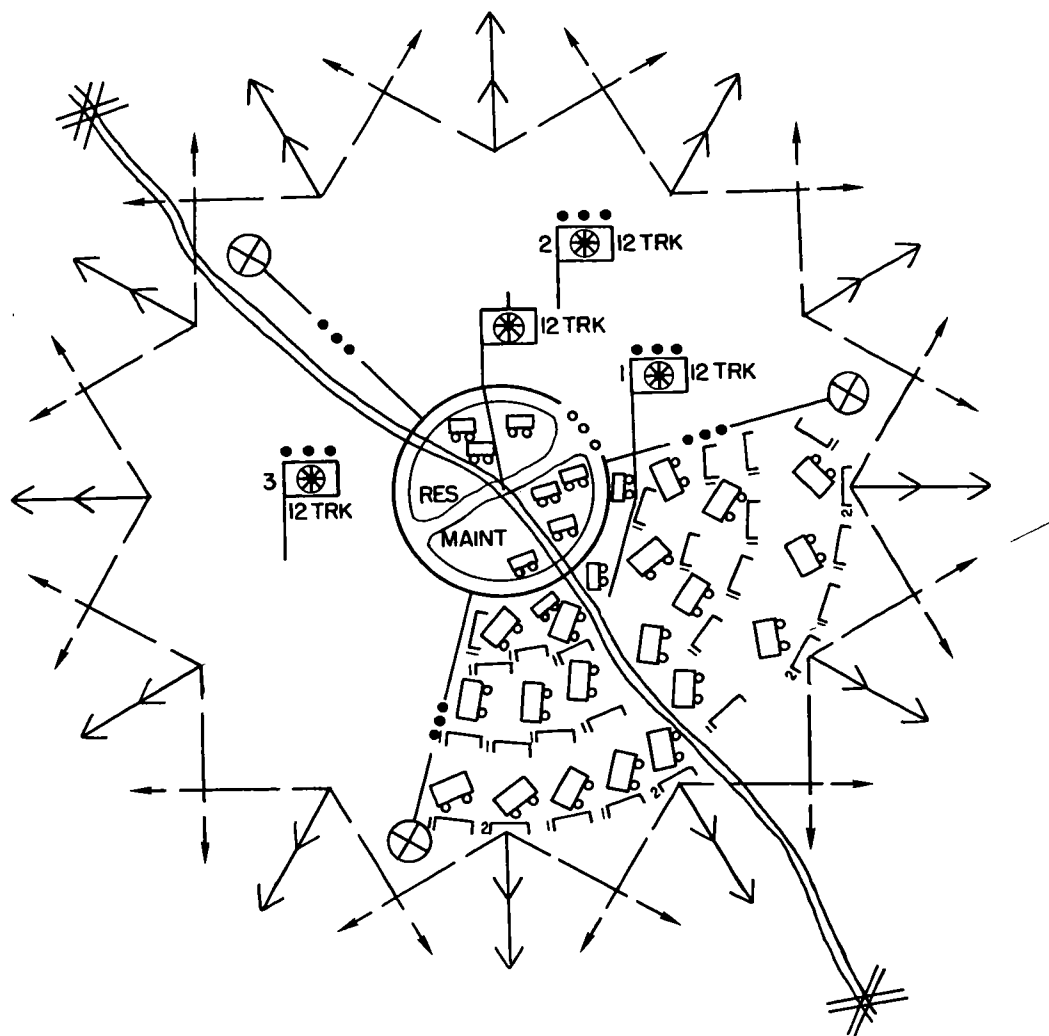
b. Mission. Service provided, extent of operation.

c. Functions.

(1) Scheduled and nonscheduled operations.

(2) Maintenance of equipment—responsibilities, procedures, facilities, and inspection practices.

d. Operational Planning. Computation of troop and equipment requirements, capability estimate, communication procedure and requirements, rehabilitation requirements.



COMPANY AREA: .0959 SQ MILES OR 61.4 ACRES
COMPANY FRONT: 1,900 YD (1,737 METERS)
PLATOON FRONT: 630 YD (576 METERS)
CP AREA: 75 YD (69 METERS) RADIUS

Figure 3-2. Schematic diagram, typical bivouac area, light truck company—passive defense emphasized.

e. Operations. Operational procedures and controls, pooling and utilization of equipment.

f. Maintenance. Responsibilities and procedures for maintenance, regulations, and reports.

g. Supply Procedure. Responsibilities for supplies, authorized levels, requisitioning procedures, accounting methods, disposal of excesses.

h. Intelligence and Reconnaissance. Responsibility for collection, collation, evaluation, and dissemination of highway transportation intelligence and reconnaissance information.

i. Security. Responsibilities, plans—disaster and defense, convoy and cargo security, equipment and facilities.

j. Records and Reports. Responsibility, operational and personnel status reports, technical reports, miscellaneous.

k. Training. Responsibility—unit and technical training.

3-6. Vehicle Commitment Format

Routine commitment of vehicles requires the type of information outlined below. Those items not required for a particular unit should be eliminated. For nonroutine commitment and commitment of an entire unit for a substantial period of time, consideration should be given to the use of the five-paragraph operation order (FM 101-5).

a. Heading. The headquarters receiving the commitment, its location, and the date and hour of receipt.

b. Task (or Request).

- (1) Request number _____
- (2) Received from _____
(name & rank) (org) (phone)
- (3) To transport _____
(tons) (type of cargo) (No. pers)
Cube _____. Peculiarities _____
(shape, etc.)
From _____. To _____
- (4) Recommended number and type of vehicles _____
- (5) Terminal capabilities.
Origin _____. Est load time _____.
Destination _____.
Est unload time _____
- (6) Vehicles report to: _____
(name, rank, title)
Location _____. Phone _____.
Time and date: Spot _____.
Move _____
- (7) On arrival at destination, report to: _____
(name, rank, title), location _____

c. Coordinating Instructions.

- (1) Type of commitment:
One-time: _____
Recurring: _____
If recurring, from _____
through _____
- (2) Road information: _____
(special routing, weather effects, limitations, etc.)
- (3) Shipment (has) (has not) been coordinated with consignor and con-

signee, regarding (refer to paragraph numbers above, or enter special information).

- (4) It (is) (is not) an emergency movement. If emergency, authorized by _____

(name, rank, title, org)

Phone _____

- (5) Trailer pickup, movement, and delivery schedule.

(Spot) (Pick up) trailers at origin at _____

(date-time)

Move trailer from _____ to _____

By date-time _____

Move trailer from _____ to _____

By date-time _____

Deliver trailers to destination for (unloading) (return loading) (return) at _____

(date-time)

d. Administrative and Logistical Matters.

- (1) Class III: (available origin) available destination) (unit provide own).
- (2) Meals and billets: (available origin) (available destination) (not available).
- (3) Remarks: _____

e. Command and Signal.

- (1) Reports required: _____
- (2) Highway clearance requested _____
(date-time)
_____, received
_____, clearance number _____
(date-time)
- (3) Special instructions: _____

3-7. Traffic Circulation Plans

(fig. 3-1).

a. Traffic circulation plans (maps) are used to indicate a road net system of routes and to give necessary information and pertinent traffic restrictions.

b. The circulation plan establishes one-way, two-way, and alternating routes of traffic flow. Care must be taken to insure that routes are available for a circuitous flow in the required directions. A one-way route normally requires

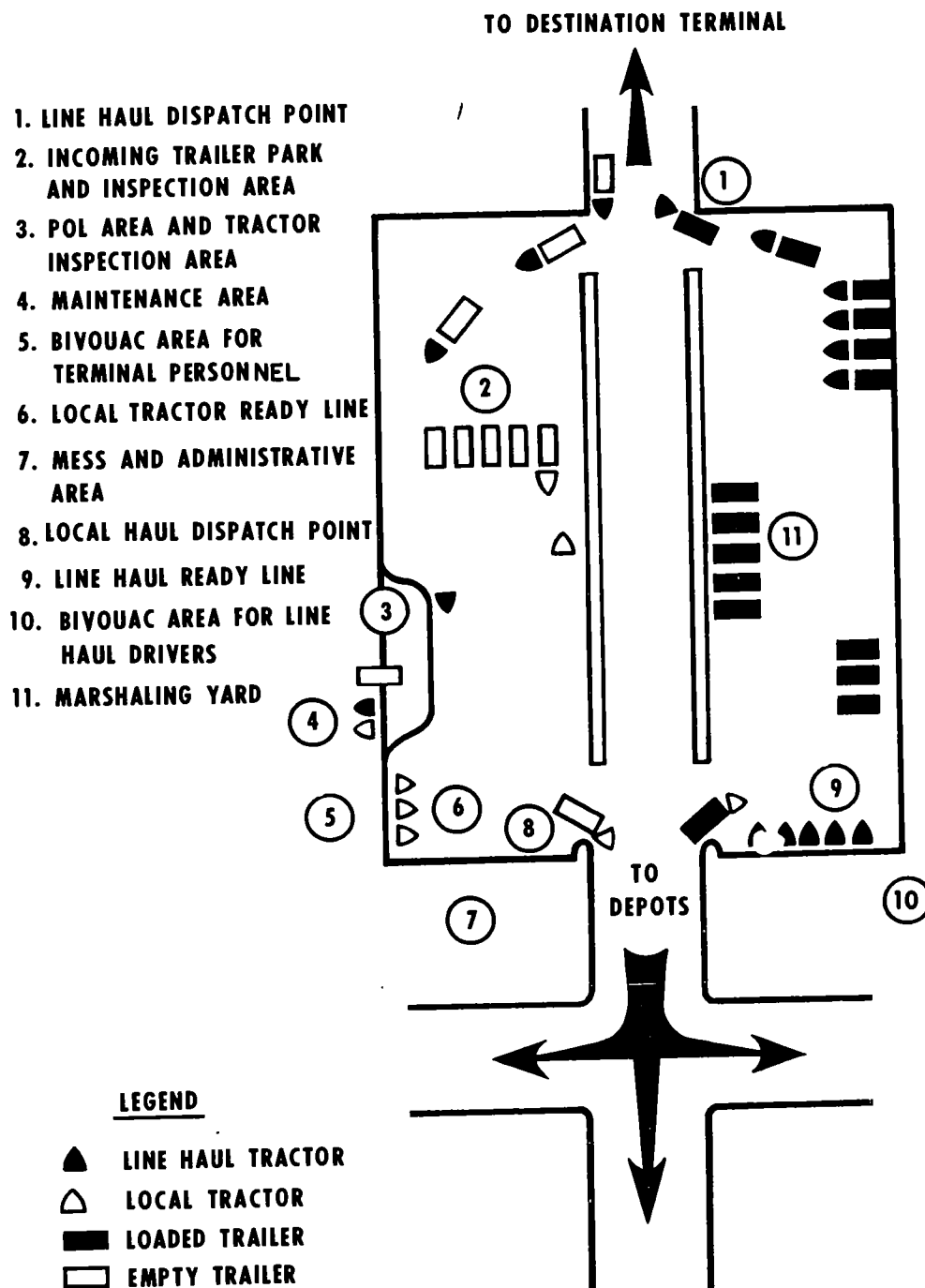


Figure 3-3. Origin truck terminal.

a compensating route in the opposite direction for the return of vehicles. Adequate access and egress routes must be provided along all routes. Where the balance between main

routes and access-egress routes is not maintained, the capability of main routes may be limited to the capability of the access or egress facilities.

c. *Traffic circulation plans* show the road net that is planned to be used and maintained and how it will be used. Normally it contains route designations and the most restrictive route features; direction of movement; location of boundaries, units, highway regulation points, traffic control posts, and principal supply activities; major geographic features; and light lines, if applicable.

d. *Circulation plans* frequently consist of a standard map and an overlay which together give the needed information. If the necessary information is too much to put on one overlay, separate overlays may be used to show different types of information. The sketch in figure 3-1 is one example of a traffic circulation plan. When making a traffic circulation plan, the planner or operator must be guided by what information is required by users of the plan.

3-9. Bivouac Defense, Truck Company

a. *Standard Pattern.* Company standing operating procedure (SOP) gives a standard pattern that can be modified to suit the situation and terrain. This SOP should contain the sound or visual signals communication plan. Upon arriving at the bivouac site, each platoon takes its predetermined position in the perimeter without orders. Company headquarters and the maintenance section occupy the center as a reserve. Figure 3-2 shows typical temporary bivouac areas for a light truck company.

b. *Conduct of Defense.* The unit commander places on the perimeter the minimum number of men required to maintain reasonable security. The number of men on the perimeter depends upon the probability of attack by regular troops or guerrillas, upon the terrain and weather—including visibility, and upon the number of men available. The unit commander keeps himself informed on the nearness and activity of enemy forces. He gains this information from his next higher headquarters, from the unit he is supporting or to which he is attached, and/or from friendly adjacent troops. When ground attack is imminent, men occupy the two-man foxholes. If required, one man stays alert while the other man sleeps.

Each squad is given a sector. The squad leader and assistant squad leader occupy positions in rear of the squad. At all times the platoon leader and the squad leaders must know exactly where their men are and be prepared to alert them immediately.

c. *Trucks.* Trucks may be dispersed individually or in small groups, with about 100 yards (91 m) between trucks or groups. Trucks are camouflaged and parked facing the nearest exit road.

d. *Mines and Flares.* If available and authorized, a protective minefield consisting of fragmentation-type antipersonnel mines and trip flares is placed around the outer rim of the perimeter about 200 yards (183 m) in front of the foxholes and machinegun emplacements (FM 20-32). One trailer in each platoon may carry numbered mines. These are placed in a standard sequence in every bivouac—mine No. 1 at 12 o'clock, then clockwise. The protective minefield can be installed quickly, and all mines can be located promptly and recovered when bivouac is cleared. Each minefield will be recorded and reported in accordance with the provisions of chapter 6, FM 20-32.

e. *Grenade Launchers and Machineguns.* Grenade launchers are used to protect areas most likely or suitable for enemy mechanized attack. Machineguns are placed to secure interlocking fires on the perimeter.

f. *Passive Defense.* The unit commander must continuously stress passive defense measures. All personnel should construct foxholes with adequate overhead cover immediately after occupying a bivouac area. Exposed personnel, even in rear areas, should be limited to the minimum number required to provide security and perform other necessary duties in the bivouac area.

3-8. Bivouac Defense, Truck Company

Figure 3-3 shows a typical origin truck terminal. Arrangement of facilities may deviate from the illustration, but the facilities indicated should be considered the minimum necessary for effective operation of the terminal.

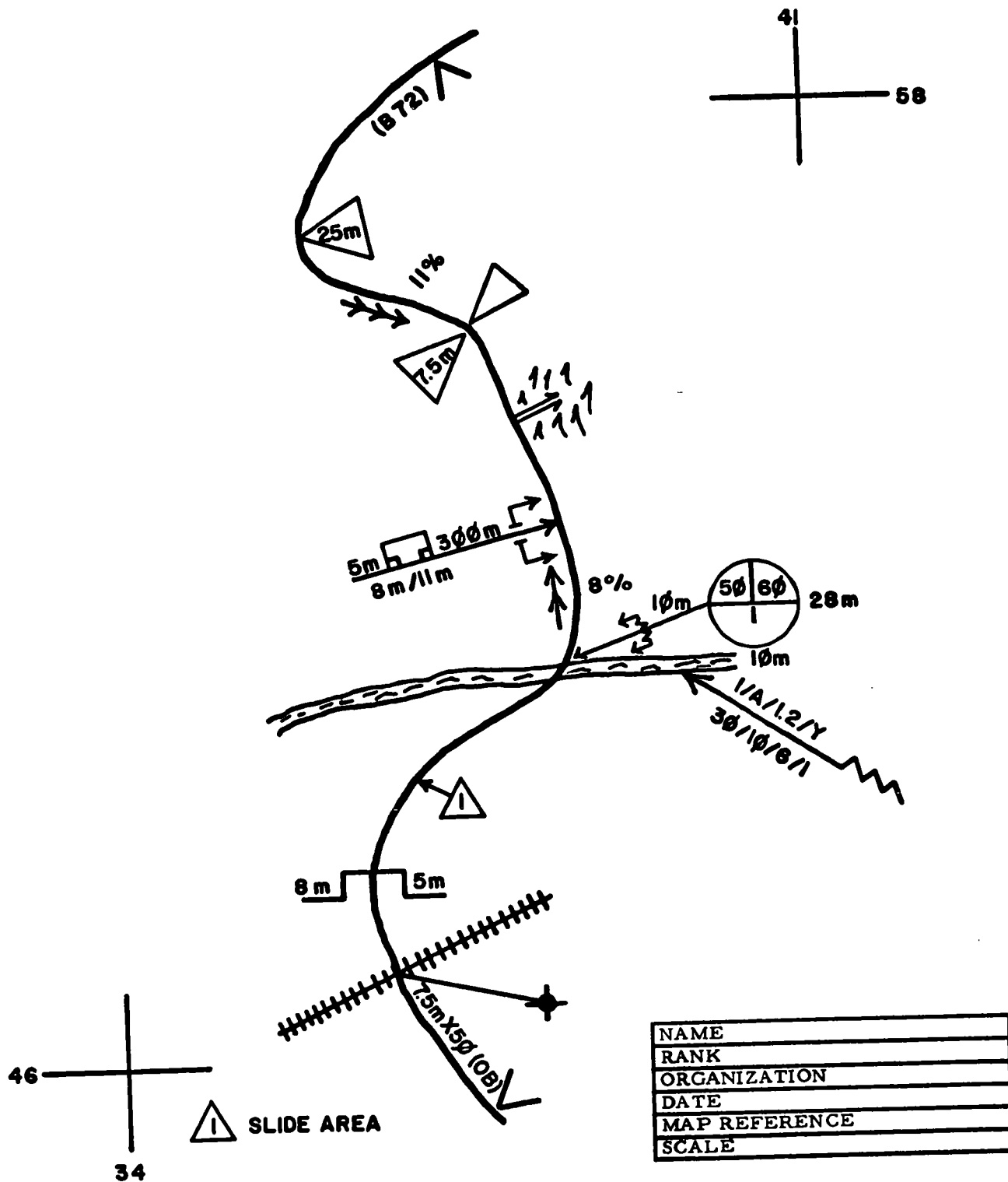


Figure 3-4. Example of route reconnaissance overlay.

3-10. Route Reconnaissance

a. Route Reconnaissance Overlay. Information obtained by either a hasty or a deliberate reconnaissance can be conveyed to interested personnel on a route reconnaissance overlay. The route reconnaissance overlay is an accurate and concise report of the conditions affecting traffic flow along a specified route and is the preferred method of preparing a route reconnaissance report. An overlay normally satisfies the requirements of hasty route reconnaissance. If, however, more detail is required to support the reconnaissance, the overlay is supplemented with written reports describing critical route characteristics in more detail. For additional information, see FM 5-36. An example of a route reconnaissance overlay is shown in figure 3-4.

b. Route Reconnaissance Checklist. To insure that critical terrain data during route reconnaissance are not overlooked and to aid in the preparation of reconnaissance reports, a checklist based on the characteristics of the area of operations is recommended. The following items should be considered in preparing reconnaissance reports:

c. Route Reconnaissance Symbols.

lowing items should be considered in preparing reconnaissance reports:

(1) Identification and location of the reconnoitered route.

(2) Distances between points easily recognized both on the ground and on the map.

(3) Percent of slope and length of grades which are 7 percent or greater.

(4) Sharp curves whose radii are 100 feet (30 m) or less.

(5) Bridge military load classifications and limiting dimensions, and suitable bypasses.

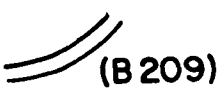
(6) Locations and limiting data of fords and ferries.

(7) Route restrictions, such as underpasses, which are below minimum standard and, if appropriate, the distances such restrictions extend.

(8) Locations and limiting dimensions of tunnels, suitable bypasses.

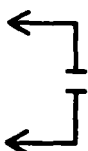
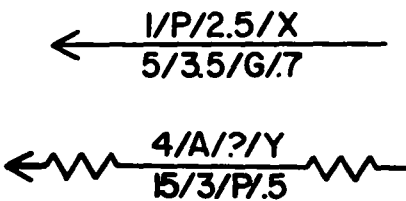
(9) Suitable areas for short halts and bivouacs which offer drive-off facilities, adequate dispersion, cover, and concealment.

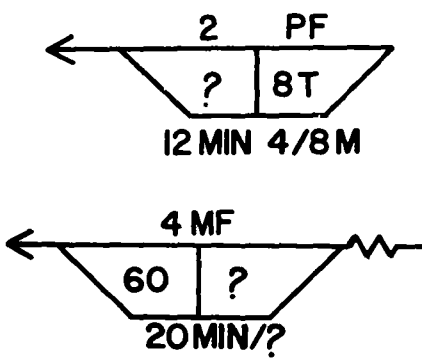
(10) Areas of rockfalls and rockslides which may present a traffic hazard.

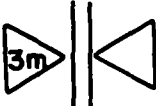
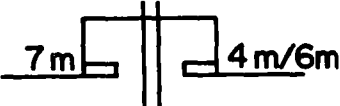
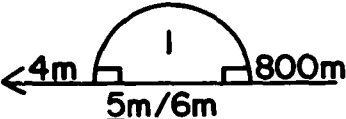
Explanation	Symbol	Remarks	Reference
Civil or military route designation		Designation written in parenthesis along route.	STANAG 2253 SOLOG 96
Critical point		To be numbered and described in legend. Critical points may be used to point out features not adequately covered in other reconnaissance symbols.	STANAG 2253 SOLOG 96
Limits of sector		Limits of reconnoitered sector of route.	STANAG 2253 SOLOG 95
Route classification formulas	10.5m X 120 6m Z 8 (OB) 9m Y 20(OB) W	Expressed in order of: width, type, military load classification, obstructions, if present, and regular flooding or snow blockage: X - all-weather route Y - all-weather route (limited traffic) Z - fair weather route T - regular snow blockage W - regular flooding	FM 5-36 (sec. I, ch 2) STANAG 2015 SOLOG 53

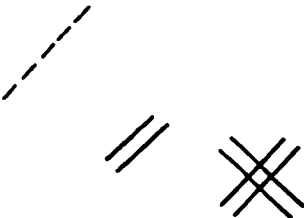
Explanation	Symbol	Remarks	Reference
Grades		Arrows point in uphill direction; to the right of symbol is shown the actual percent of slope; length of arrow represents length of grade if map scale permits.	FM 5-36 (sec. III, ch 2) STANAG 2253 SOLOG 96
Sharp curves		Vertex of triangle points to map location of curve. Radius in feet or meters is inscribed within symbol.	FM 5-36 (sec. II, ch 2) STANAG 2253 SOLOG 96
Full bridge symbol		Arrow extends to map location of bridge; minimum width is placed below, overhead clearance to the left, and overall length to the right of basic symbol. Lower portion of symbol indicates bridge serial number; upper portion, military load classification data. Underlined values are those below minimum standard.	FM 5-36 (sec. VII, ch 2) DA Form 1295 STANAG 2096 STANAG 2252 SOLOG 94 SOLOG 107

Explanation	Symbol	Remarks	Reference
Abbreviated bridge symbol		Arrow extends to map location of bridge. Lower portion of symbol indicates bridge serial number; upper portion, military load classification for single flow traffic; asterisk denotes other classifications to be found in accompanying inclosure.	FM 5-36 (sec. VI, ch 2) DA Form 1249 STANAG 2096 STANAG 2252 SOLOG 94 SOLOG 107
Bypass easy		Used in conjunction with bridge and tunnel reconnaissance symbols.	FM 5-36 (sec. VII, ch 2) STANAG 2252 STANAG 2253 SOLOG 94 SOLOG 96
Bypass difficult		Used in conjunction with bridge and tunnel reconnaissance symbols.	FM 5-36 (sec. VII, ch 2) STANAG 2252 STANAG 2253 SOLOG 94 SOLOG 96

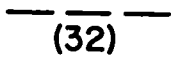
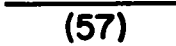
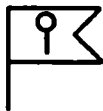
Explanation	Symbol	Remarks	Reference
Bypass impossible		Used in conjunction with bridge and tunnel reconnaissance symbols.	FM 5-36 (sec. VII, ch 2) STANAG 2252 STANAG 2253 SOLOG 94 SOLOG 96
Ford		Arrow extends to ford location. Data above the lines expressed in order of serial number, ford type, stream velocity in meters per second, and seasonal limitations. Data below the line expressed in order of length, width, bottom type and depth. Question marks indicate unknown information. Difficult approaches are represented by zigzag lines corresponding in position to shore where approach is located. <u>Ford type</u> A-vehicular P-foot D-deepwater, tank S-swimming vehicles <u>Seasonal variations</u> X-none Y-significant	FM 5-36 (sec. V, ch 2) DA Form 1251 STANAG 2274 STANAG 2096 SOLOG 107

Explanation	Symbol	Remarks	Reference
Ford (Cont)		<u>Bottom type</u> M-mud C-clay S-sand G-gravel R-rock P-artificial paving	
Ferry		Arrow extends to map location. Data above symbol is expressed in order of ferry serial number and ferry type. Data inside symbol are expressed in order of military load classification and dead weight capacity; data below symbol are expressed in order of turnaround time and width and length of cargo space. Question mark indicates unknown information. Difficult approaches are represented by zigzag lines corresponding in position to shore where approach is located. <u>Ferry type</u> AF-vehicular PF-foot MF-military	FM 5-36 (sec. V, ch 2) DA Form 1252 STANAG 2096 STANAG 2274 SOLOG 107

Explanation	Symbol	Remarks	Reference
Width constriction		Route constriction in width; width expressed in feet or meters of usable traveled way in triangle corresponding to the side of traveled way in which the constriction occurs.	FM 5-36 (sec. IV, ch 2) STANAG 2253 SOLOG 96
Arch constriction		Width expressed in meters or feet to right of symbol, overhead clearance to left.	FM 5-36 (sec. V, ch 2) STANAG 2253 SOLOG 96
Rectangular construction with sidewalks		Width of traveled way followed by total width including sidewalk expressed in feet or meters to right of symbol, overhead clearance to left.	FM 5-36 (sec. IV, ch 2) STANAG 2253
Tunnel with sidewalks		Arrow extends to map location. Serial number is placed inside the symbol. The width of the traveled way followed by total width including sidewalks in meters or feet is placed below the symbol. Underlined widths indicate reduction of widths below that of the outside route.	FM 5-36 (sec. IV, ch 2) DA Form 1250 STANAG 2096 STANAG 2274 SOLOG 107

Explanation	Symbol	Remarks	Reference
Tunnel with sidewalks (Cont)		Overhead clearance is placed to the left of the symbol and total tunnel length to the right. A question mark represents unknown information. Bypasses are shown by standard symbol notations	
RR grade crossing		Level crossing; passing trains will interrupt traffic flow.	STANAG 2253 SOLOG 96
Concealment		Route lined with trees; deciduous trees (left) and evergreen (right).	STANAG 2253 SOLOG 96
Concealment and vehicular turnoff		Arrow denotes possibility of driving off route for concealment in a mixed forest stand.	STANAG 2253 SOLOG 96
Roadblock, craters, and blown bridges		Center of the symbol indicates position of block.	FM 21-30 STANAG 2019 SOLOG 28

- a. Proposed
b. Prepared but passable
c. Completed

Explanation	Symbol	Remarks	Reference
Lateral route		Broken lines; identified by even number.	FM 5-36 (sec. I, ch 2) STANAG 2151
Axial route		Solid line; identified by odd number.	FM 5-36 (sec. I, ch 2) STANAG 2151
Unknown or doubtful information			FM 21-30 STANAG 2019 SOLOG 28
Parking area			FM 21-30 STANAG 2019 SOLOG 28
Traffic control post			FM 21-30 STANAG 2019 SOLOG 28
Traffic control headquarters			FM 21-30 STANAG 2019 SOLOG 28

3-11. Route Classification

For the purpose of classification, routes are designated by their ability to withstand the effects of weather. Route type is determined by the worst section of the route. Routes as classified by types are—

a. Type X. All-weather route is any route which, with reasonable maintenance, is passable throughout the year to traffic never appreciably less than maximum capacity. The roads which form this type of route normally have waterproof surfaces and are only slightly affected by precipitation or temperature fluctuations. At no time is the route closed to traffic by weather effects other than temporary snow or flood blockage.

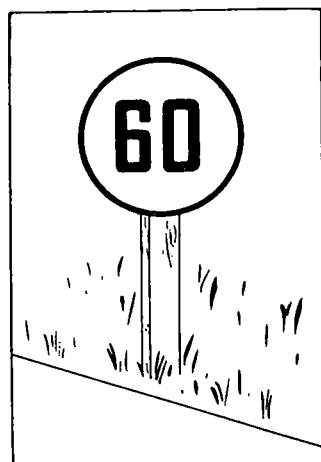
b. Type Y. All-weather route (limited traffic due to weather) is any route which, with reasonable maintenance, can be kept open in all

weather but sometimes only to traffic considerably less than maximum capacity. The roads which form this type of route usually do not have waterproof surfaces and are considerably affected by precipitation or temperature fluctuations. Traffic may be completely halted for short periods. Heavy unrestricted use during adverse weather may cause complete collapse of the surface.

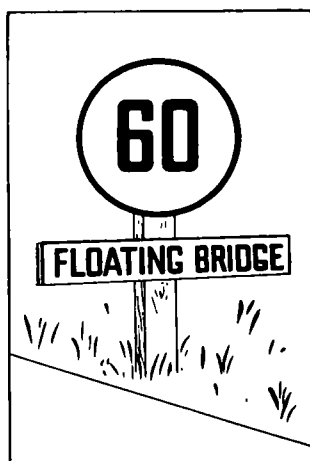
c. Type Z. Fair weather route is any route which quickly becomes impassable in adverse weather and cannot be kept open by maintenance short of major construction. This category of route is so seriously affected by weather that traffic may be brought to a halt for long periods.

3-12. Military Load Classification

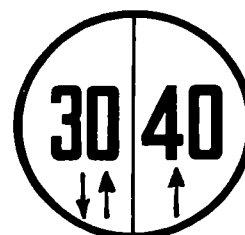
The military load classification system is a load capacity rating system which considers a



For single-lane fixed bridge.



For single-lane floating bridge.



Two-way sign limiting vehicle classes on a two-lane bridge when used as a two- or as a single-lane bridge.

Figure 3-5. Typical bridge-class and information signs.

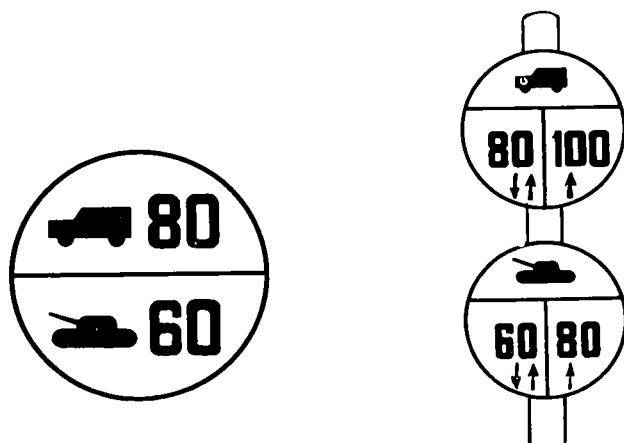


Figure 3-6. Typical dual-class bridge signs.

vehicles' weight and type and its effect on routes and bridges. The classification system is represented by whole numbers assigned to vehicles, bridges, and routes. (For detailed discussion, see FM 5-36.) Most allied military vehicles are externally marked with their respective classification number. Bridges and routes are assigned military load classification based on their safe load capacity and physical dimensions.

a. *Route Classification.* Normally, the lowest

bridge military load classification number regardless of vehicle type or conditions of traffic flow determines the military load classification of a route. By selecting the lowest bridge classification number, it is assured that the route is not overloaded. In those cases where vehicles bear a higher military load classification than the route, the route reconnaissance overlay is checked or a special reconnaissance is initiated to determine if a change in traffic control procedures, such as a single-flow crossing, may permit use of the route by heavier traffic. If no bridge is located on the route or if roads are particularly bad, the worst section of road governs the route's classification.

b. *Obstructions to Traffic Flow.* Route obstructions are factors which restrict the type and amount or speed of traffic flow. Route obstructions, with the exception of bridge capacities, which are reported separately as a military load classification, are indicated in the route classification formula (para 3-13) by the abbreviation OB. Moreover, reconnaissance symbols are used to describe the nature of each obstruction on the route reconnaissance overlay. Obstructions to be reported include—

(1) Overhead obstructions such as bridges, tunnels, underpasses, overhead wires,

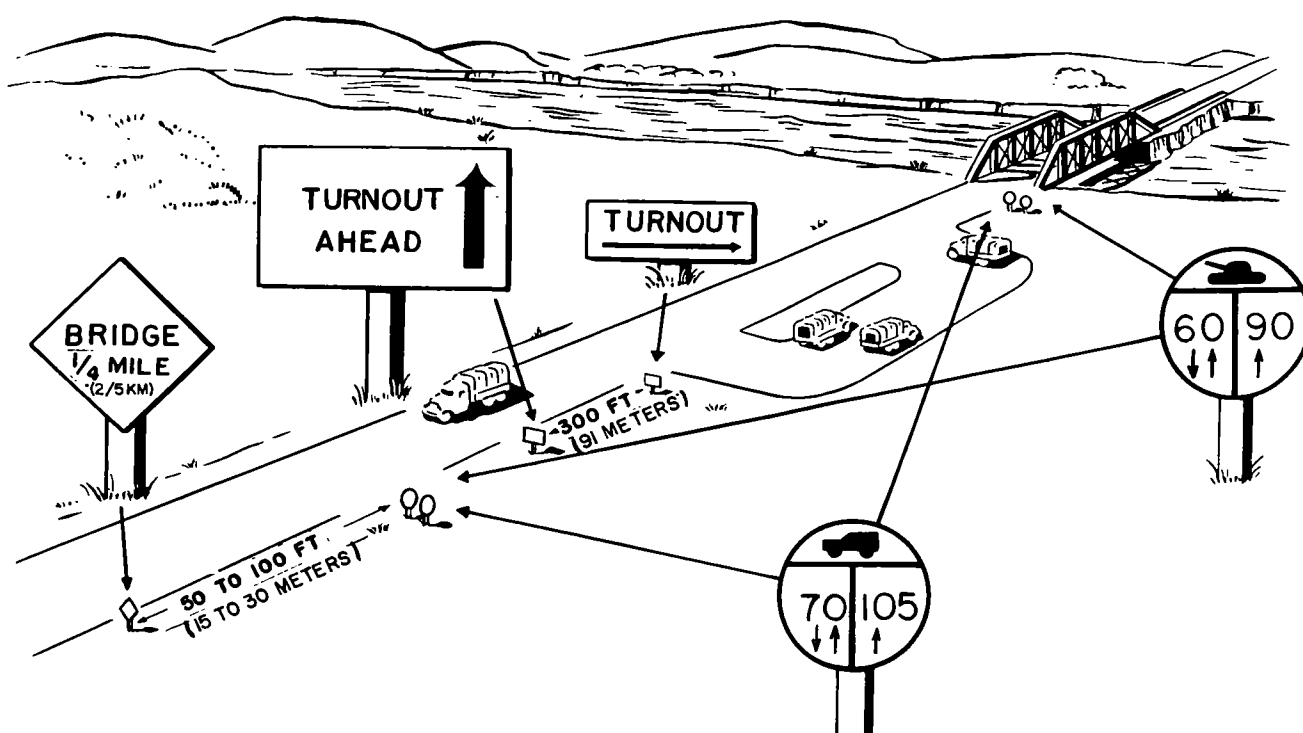


Figure 3-7. Typical arrangement of road-guide, information, and two-lane bridge-class signs.

and overhanging buildings whose overhead clearance is less than 14 feet (4.25 m).

(2) Reduction in traveled way widths which are below standard minimums prescribed for the type of traffic flow (single or double, wheeled or tracked, see FM 5-36). Examples are bridges, tunnels, craters, lanes through mined areas, and projecting buildings or rubble.

(3) Gradients (slopes) of 7 percent or greater.

(4) Curves whose radii of curvature are less than 100 feet (30 m).

(5) Ferries.

(6) Fords.

3-13. Route Classification Formula

The route classification formula is developed from notations expressed in the standardized sequence of minimum traveled way width, route type, lowest military load classification, and obstruction(s) if present. The formula briefly describes a specific route and is used together with a route reconnaissance overlay.

If an obstruction(s) appears in the route classification formula, it is necessary to refer to the route reconnaissance overlay in order to determine the exact nature and location of the obstruction(s). Illustrative formulas are shown in *a* through *d* below.

a. 20 Ft Z 10. This example formula describes a fair-weather route with a minimum traveled way of 20 feet and a military load classification of 10. This route, based on its minimum width of traveled way accommodates both wheeled and tracked, single-flow traffic without obstruction. Minimum route widths, according to STANAG 2151, for wheeled and tracked vehicles in single and double flow traffic are tabulated below.

Traffic flow possibilities	Route Widths (STANAG 2151)	
	Widths for wheeled vehicles	Widths for tracked vehicles
Single flow	18 to 3 feet (5.5 to 7 m).	19.5 to 26 feet (6 to 8 m).
Double flow	Over 23 feet (7 m).	Over 26 feet (8 m).

b. 20 Ft Z 10 (OB). This example formula describes a route with similar characteristics

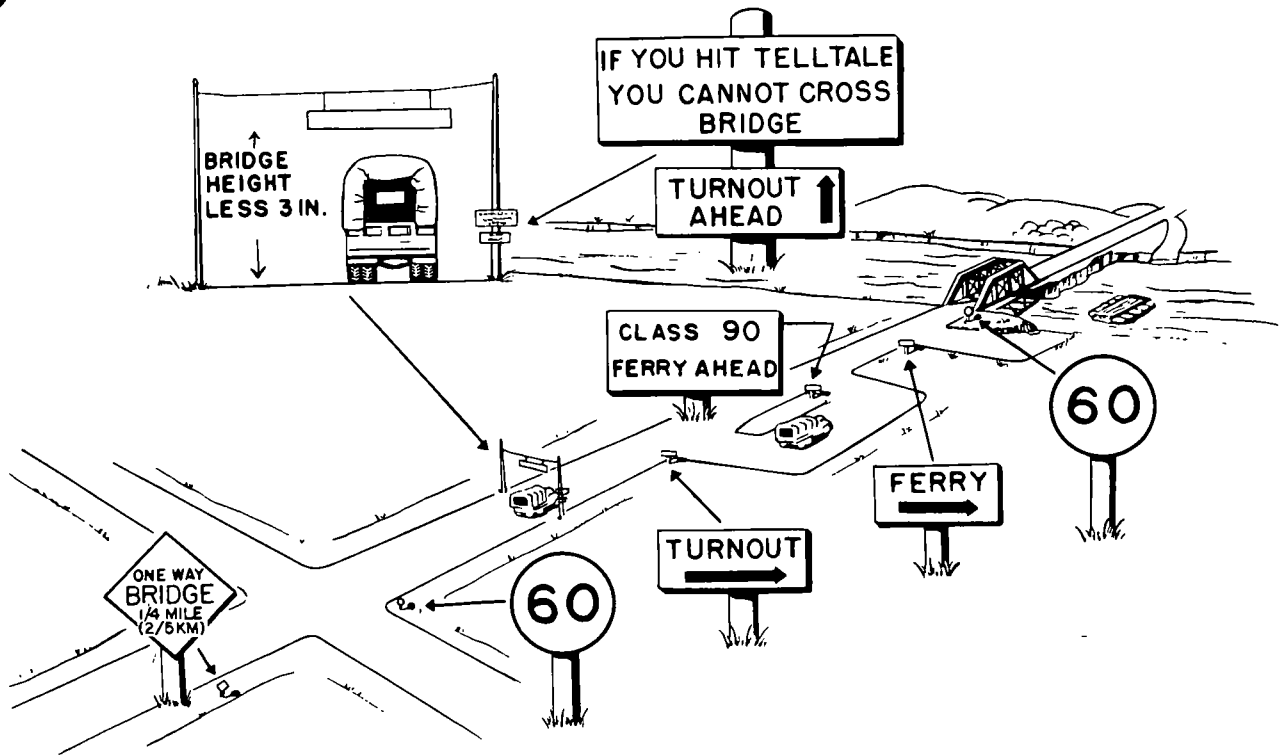


Figure 3-8. Typical arrangement of road-guide, information, and single-lane bridge-class signs.

as in *a* above, but with obstruction(s). It should be noted that 20 feet of traveled way limits this route to single-flow traffic without a width obstruction. If the route is to be used for double-flow traffic, however, 20 feet of traveled way constitutes an obstruction and is indicated in the formula both as a minimum traveled way width (20 ft) and as an obstruction.

c. 7 m Y 50 (OB). This example formula describes a limited all-weather route with a minimum traveled way width of 7 meters and a military load classification of 50 with obstruction(s). The traveled way width of this route is adequate for wheeled, but not tracked, vehicles in double-flow traffic. Therefore, this width constriction would be indicated as (OB) in the route classification formula if the route were to be used for both types of vehicles.

d. 10.5 × 120 (OB). This example formula describes an all-weather route with a minimum traveled way width of 10.5 meters, which

is suitable for double-flow traffic of both wheeled and tracked vehicles, a military load classification of 120 with obstruction(s).

3-14. Bridge Signs

a. Circular Signs (figs. 3-5 and 3-6). These are placed at bridges to indicate the bridge classification. The signs have a yellow background; the bridge classification and appropriate symbol are in black.

b. Rectangular Signs (figs. 3-7 and 3-8). These signs give additional instructions and technical information. Minimum size is 16 inches high or wide. They have a yellow background and black symbols and lettering.

3-15. Bridge and Vehicle Weight Classification

a. Posting Bridges. Every military bridge is posted with a number indicating the highest vehicle weight class that can cross safely. Vehicles of higher weight class are barred except for special crossings. Fixed bridges may also

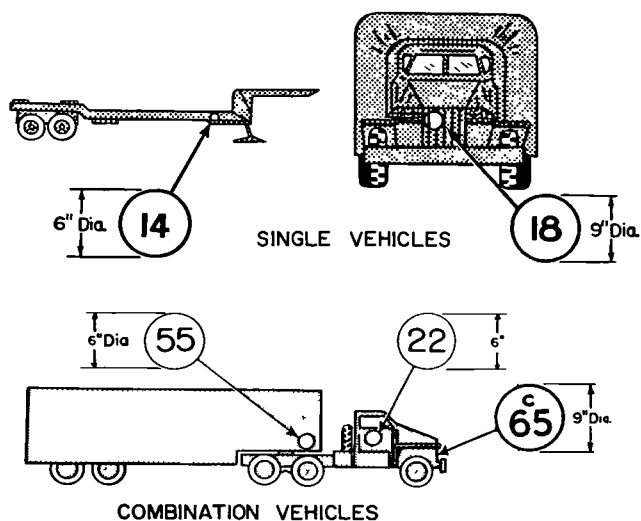


Figure 3-9. Vehicle weight classification marking.

be marked with the length in feet of the span to which the posted capacity applies.

b. Marking Vehicles. Self-propelled vehicles in class 3 or higher and towed vehicles in class 1 or higher are marked to indicate the class, except that prime movers are marked with either their own class or the class of the nor-

mal combination of prime mover and trailer or semitrailer. Markings on the front of the trucks should be on the right front, on or above the bumper, but below the driver's vision. Examples of vehicle markings are shown in figure 3-9.

c. Military Load Classification List. The symbols found in the heading of the listing are defined below:

E—Weight or class of vehicle without payload

C—Weight or class of vehicle combat loaded or with rated maximum cross-country payload

H—Weight or class of vehicle combat loaded with rated maximum highway payload

The weight classification number to be posted on vehicles will be assigned from the number listed under "C" subcolumn of the class column. This number is taken from the normal design load of the vehicle. Where no number appears in the "C" column, take the number appearing in the "H" column, and if both of these columns are blank take the number from the "E" column.

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
TRACKED VEHICLES						
Bulldozer, earthmoving, M4, tank-mtd (light tank M24) -----	20.70	22.05	22.05	20	22	22
Bulldozer, earthmoving, M6, tank-mtd (tank, combat, 90mm gun M47).	40.50	51.60	51.60	50	53	53
Bulldozer, earthmoving, M8 (tank, combat, 90mm gun M48) ----	52.89	57.39	57.39	52	60	60
Bulldozer, earthmoving, tank-mtd, M9 (tank, combat, 105mm gun, M60 and M60A1).	52.94	54.74	54.74	50	52	52
Bulldozer, earthmoving, tractor-mtd, M5 (tractor, high-speed, M8A2).	24.25	33.50	33.50	23	32	32
Carrier, cargo, amphibious, M76 -----	4.16	6.02	6.02	4	6	6
Carrier, cargo, amphibious, tracked, M116 -----	3.94	5.44	5.44	4	5	5
Carrier, cargo, tracked, 6-ton, XM548E1 -----	8.00	14.00	14.00	7	13	13
Carrier, command post, light-tracked, XM577 -----	11.40	11.95	11.95	11	11	11
Carrier, personnel, full-tracked, armored, M59 -----	19.75	21.30	21.30	18	19	19
Carrier, personnel, full-tracked, armored, M75 -----	18.34	20.75	20.75	17	20	20
Carrier, personnel, full-tracked, armored, M113 -----	11.71	11.95	11.95	9	9	9
Carrier, personnel, full-tracked, armored, M114A1 -----	6.45	7.37	7.37	7	7	7
Flamethrower, self-propelled, M132 -----	---	11.46	11.46	---	9	9
Gun, antiaircraft artillery, self-propelled, twin 40mm, M42 and M42A1.	22.15	24.90	24.90	20	23	23
Gun, antiaircraft, artillery, self-propelled, twin 40mm, M19A1 --	16.88	19.25	19.25	16	18	18
Gun, antitank, self-propelled, 90mm, M56 -----	6.25	7.87	7.87	6	8	8

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Gun, field artillery, self-propelled, 155mm, M53	44.50	48.00	48.00	42	46	46
Gun, field artillery, self-propelled, 175mm, M107	28.80	31.05	31.05	29	29	29
Howitzer, heavy, self-propelled, full-tracked, 8-inch, M55	45.00	49.00	49.00	41	46	46
Howitzer, heavy, self-propelled, 8-inch, M110	26.80	29.25	29.25	27	27	27
Howitzer, light, self-propelled, full-tracked, 105mm, M37	19.32	23.00	23.00	18	22	22
Howitzer, light, self-propelled, full-tracked, 105mm, M52 and M5A1.	24.90	26.50	26.50	23	25	25
Howitzer, light, self-propelled, 105mm, M108	18.00	23.11	23.11	20	20	20
Howitzer, medium, self-propelled, full-tracked, 155mm, M44 and M44A1.	29.00	32.00	32.00	27	30	30
Howitzer, medium, self-propelled, 155mm, M109	21.75	26.23	26.23	24	24	24
Landing vehicle, tracked, command, M5 (LVTP5A1 (CMD))	32.1	36.23	36.23	28	36	36
Landing vehicle, tracked, engineer, M1 (LVTE1)	41.37	48.75	48.75	37	46	46
Landing vehicle, tracked, howitzer, M6 (LVTH6A1)	37.10	43.30	43.30	33	40	40
Landing vehicle, tracked, personnel, M5 (LVTP5A1)	32.1	43.89	43.89	28	40	40
Landing vehicle, tracked, recovery, M1 (LVTR1A1)	37.51	41.10	41.10	33	37	37
Landing vehicle, tracked, armored, MK4	17.72	20.00	20.00	15	18	18
Landing vehicle, tracked, MK4	13.70	18.20	18.20	12	16	16
Launcher, M48A2 tank chassis, transporting	---	49.29	49.29	--	50	50
Launcher, M48A2 tank chassis, transporting, with bridge armored vehicle launched, scissoring type, Class 60.	---	64.4	64.4	--	64	64
Launcher, M60 chassis, transporting	---	41.0	41.0	--	38	38
Launcher, M60 chassis, transporting, with bridge armored vehicle launched, scissoring type, Class 60.	---	50.6	50.6	--	54	54
Mortar, infantry, self-propelled, full-tracked, 107mm (4.2 inch) M84.	20.56	23.55	23.55	19	22	22
Recovery vehicle, full-tracked, heavy, M51	56.25	60.00	60.00	54	58	58
Recovery vehicle, full-tracked, medium, M74	44.30	46.87	46.87	51	54	54
Recovery vehicle, full-tracked, medium, M88	54.00	56.00	56.00	53	55	55
Recovery vehicle, full-tracked, light, armored, M578	23.5	27.00	27.00	25	25	25
Rifle, self-propelled, full-tracked, multiple, 106mm, M50	8.22	9.52	9.52	8	9	9
Tank, combat, light, 75mm gun, M24	18.90	20.25	20.25	18	19	19
Tank, combat, full-tracked, 76mm, M41, M41A1, M41A2, and M41A3.	22.35	25.90	25.90	21	25	25
Tank, combat, full-tracked, medium, 90mm gun, M46 and M46A1	46.40	48.50	48.50	45	48	48
Tank, combat, full-tracked, 90mm gun, M47	46.50	48.50	48.50	45	48	48
Tank, combat, full-tracked, 90mm gun, M48 and M48C	46.56	49.50	49.50	46	50	50
Tank, combat, full-tracked, 90mm gun, M48A1, M48A2, and M48A2C.	48.50	52.00	52.00	46	52	52
Tank, combat, full-tracked, 105mm gun, M60 and M60A1	47.65	52.50	52.50	45	50	50
Tank, combat, full-tracked, 120mm gun, M103 and M103A1	58.50	62.50	62.50	57	61	61
Tank, combat, full-tracked, flamethrower, M67A1	50.48	52.89	52.89	51	51	51
Tractor, full-tracked, high-speed, 13-ton, M5, M5A1, M5A2, and M5A4.	12.60	15.17	15.17	12	14	14
Tractor, full-tracked, high-speed, 18-ton, M4, M4A1, M4A1C, M4A2 and M4C.	13.56	15.70	15.70	13	15	15
Tractor, full-tracked, high-speed, M8A1 and M8A2	22.25	31.50	31.50	21	30	30
Tractor, full-tracked, high-speed, 38-ton, M6	34.30	38.00	38.00	32	37	37
Vehicle, combat engineer, full-tracked, T118E1	50.45	57.5	57.5	54	57	57

HALF-TRACKED VEHICLES

Car, half-track, M2A1	---	9.80	9.80	--	9	9
Carriage, motor, multiple gun, M16	---	10.82	10.82	--	10	10
Carrier, 81mm mortar, half-track, M21	---	10.00	10.00	--	9	9
Carrier, personnel, half-track, M3 and M3A1	---	10.25	10.25	--	9	9

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
WHEELED VEHICLES						
Ambulance, metropolitan, 4-litter, 3/4 ton	2.70	----	3.52	3	--	4
Bus, ambulance, 18-litter, 4x2	9.04	----	10.79	8	--	9
Bus, 29-passenger, 4x2	5.25	----	7.75	5	--	8
Bus, 37-passenger, 4x2	7.60	----	11.95	7	--	12
Bridge, float, mobile assault amphibious (French)	----	26.50	26.50	--	25	25
Car, armored, light, 6x6, M8	----	8.25	8.25	--	8	8
Car, armored, type V-100 (commando)	6.80	8.13	8.13	7	8	8
Car, armored, utility, M20	----	7.83	7.83	--	7	7
Chassis, truck, 2 1/2-ton, 6x6, M44 and M44C	5.33	----	----	5	--	--
Chassis, truck, 2 1/2-ton, 6x6, M45 and M45C	5.47	----	----	5	--	--
Chassis, truck, 2 1/2-ton, 6x6, M46 and M46C	5.64	----	----	5	--	--
Chassis, truck, 2 1/2-ton, 6x6, M57	5.41	----	----	5	--	--
Chassis, truck, 2 1/2-ton, 6x6, M58	5.43	----	----	5	--	--
Chassis, truck, 2 1/2-ton, 6x6, M133	5.58	----	----	5	--	--
Chassis, truck, 2 1/2-ton, 6x6, M207 and M207C	5.80	----	----	5	--	--
Chassis, truck, 2 1/2-ton, 6x6, M209	5.60	----	----	5	--	--
Chassis, truck, 5-ton, 6x6, M39	8.77	----	----	8	--	--
Chassis, truck, 5-ton, 6x6, M40 and M40C	9.20	----	----	8	--	--
Chassis, truck, 5-ton, 6x6, M61	9.02	----	----	8	--	--
Chassis, truck, 5-ton, 6x6, M63 and M63C	9.62	----	----	8	--	--
Chassis, truck, 5-ton, 6x6, M139, M139C and M39D	13.68	18.68	23.68	8	--	--
Decontaminating apparatus, power-driven, trk-mtd, M9, M45 chassis.	8.38	10.08	10.08	7	9	9
Decontaminating apparatus, power-driven, trk-mtd, M3A3, M45 chassis.	7.14	8.84	8.84	6	7	7
Lighter, amphibious, resupply, cargo, 5-ton, (LARC-V)	10.00	15.00	15.00	10	15	15
Lighter, amphibious, resupply, cargo, 15-ton, (LARC-XV)	22.50	37.50	37.50	27	50	50
Service unit, flamethrower, trk-mtd, M4, M45 chassis	----	938	9.38	--	8	8
Shop equipment, contact maintenance, set No. 3	----	4.45	4.45	--	4	4
Shop equipment, emergency repair, M2	----	3.88	3.88	--	4	4
Shop equipment, general purpose repair	----	8.44	8.44	--	8	8
Shop equipment, organizational repair, set No. 2	----	12.0	12.0	--	10	10
Shop equipment, heavy mach shop	----	7.70	7.70	--	8	8
Shop equipment, small tool repair	----	8.44	8.44	--	8	8
Shop equipment, welding	----	7.70	7.70	--	8	8
Superstructure transporter, amphibious, self-propelled, with superstructure, interior bay mobile assault bridge-ferry.	----	23.35	23.35	--	21	21
Superstructure transporter, amphibious, self-propelled, with superstructure, end bay mobile assault bridge-ferry.	----	25.80	25.80	--	24	24
Topographic reproduction set, trk-mtd, 2 1/2-ton truck, 6x6, carrying one of the following sections:						
Photo mechanical process section	----	12.13	12.13	--	11	11
Plate grainer section	----	10.21	10.21	--	10	10
Press section	----	11.53	11.53	--	11	11
Map layout section	----	9.04	9.04	--	9	9
Plate process section	----	9.47	9.47	--	9	9
Camera section	----	9.74	9.74	--	10	10
Topographic photomapping equipment, trk-mtd 2 1/2-ton, 6x6, carrying one of the following sections:						
Cartographic section	----	10.82	10.82	--	10	10
Copy and supply section	----	11.97	11.97	--	10	10
Rectifier section	----	12.03	12.03	--	11	11
Map revision section	----	10.49	10.49	--	9	9
Multiplex section	----	12.13	12.13	--	11	11
Photomapping section	----	10.72	10.72	--	9	9

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Truck, ambulance, 3/4-ton, 4x4, M43	4.39	5.90	5.90	3	4	4
Truck, ambulance, 1 1/4-ton, 4x4, XM676	2.51	3.50	3.50	2	3	3
Truck, amphibious, 2 1/2-ton, 6x6, DUKW, M147	9.60	12.10	13.60	9	11	13
Truck, body and hydraulic crane, fwd model B-666	13.80	-----	-----	12	--	--
Truck, bolster, 2 1/2-ton, 6x6, M44 chassis	5.49	-----	-----	8	--	--
Truck, bolster, 2 1/2-ton, 6x6, M45 chassis	6.5	-----	-----	8	--	--
Truck, bolster, 5-ton, 6x6, M40	9.49	-----	-----	7	--	--
Truck, cargo, 3/4-ton, 4x4, M37 and M37B1	2.85	3.60	4.85	3	4	4
Truck, cargo, 1 1/2-ton, 4x4, XM676	2.33	3.50	3.50	2	3	3
Truck, cargo, 1 1/2-ton, 4-door, 4x4, XM677	2.48	3.50	3.50	2	3	3
Truck, carryall, 1 1/4-ton, 4x4, XM678	2.51	3.50	3.50	2	3	3
Truck, cargo, 2 1/2-ton, 6x6, M34	6.10	8.77	11.27	5	8	10
Truck, cargo, 2 1/2-ton, 6x6, M35	6.44	8.94	11.44	5	8	10
Truck, cargo, 2 1/2-ton, 6x6, M36 and M36C	7.62	10.12	12.62	6	8	10
Truck, cargo, 2 1/2-ton, 6x6, M135	6.37	9.04	11.54	6	9	11
Truck, cargo, 2 1/2-ton, 6x6, M211	6.79	9.47	11.97	6	8	11
Truck, cargo, 5-ton, 6x6, M41	9.62	14.92	17.42	9	15	18
Truck, cargo, 5-ton, 6x6, M54	9.97	14.97	19.97	9	14	19
Truck, cargo, 5-ton, 6x6, M54A2	10.46	15.46	20.46	9	14	20
Truck, cargo, 5-ton, 6x6, M55 and M55A2	12.03	17.03	22.03	10	16	21
Truck, cargo, 16-ton, 4x4, XM437E1	19.34	35.54	35.54	--	--	--
10' span	-----	-----	-----	22	45	45
Spans over 50'	-----	-----	-----	16	30	30
Truck, cargo, 10-ton, 6x6, M125	16.89	26.89	31.89	14	25	33
Truck, cargo, 8-ton, 4x4, XM520E1 (GOER)	12.18	20.38	20.38	12	18	18
Truck, command, 3/4-ton, 4x4, M42	2.98	3.73	3.90	3	4	4
Truck, dump, 2 1/2-ton, 6x6, M59	7.23	9.91	12.41	6	8	10
Truck, dump, 2 1/2-ton, 6x6, M215	7.44	9.49	12.11	7	9	11
Truck, dump, 2 1/2-ton, 6x6, M342	7.70	10.29	12.79	7	9	12
Truck, dump, 5-ton, 6x6, M51	11.33	16.33	21.33	10	16	21
Truck, dump, 10 cu yd, (15-ton) white model SB-3001, 2320-540-3119.	17.70	-----	32.70	18	--	76
Truck, dump, 15-ton, 4x2, DED euclid M5FD	14.3	29.3	29.3	15	72	72
Truck, dump, 15-ton, 4x2, DED MACK model LR	16.25	31.25	31.25	15	72	72
Truck, dump, 15-ton, 4x2, GED sterling MSB-301	17.71	31.25	32.71	18	76	76
Truck, firefighting, pumper hesse, M-HC-26, 500 GPM, 2 1/2-ton, 6x6, M44 chassis.	8.7	10.3	10.3	8	9	9
Truck, firefighting, crash and pumper, water, 1500 GPM, 7-ton GED.	12.78	18.00	18.00	11	17	17
Truck, hopper, 5-ton, international model 201, 2320-273-4426 ...	6.12	-----	11.10	5	--	13
Truck, lift, fork, GED, rough terrain, pneumatic tired, 6000-pound cap, at 24-in. load center, baker model, RJF-060:	-----	-----	-----	-----	-----	-----
FSN 3930-679-4458	8.51	11.51	11.51	9	16	16
FSN 3930-073-8751	11.00	14.00	14.00	12	18	18
FSN 3930-073-8750	15.30	20.30	20.30	15	29	29
Truck, maintenance, 3/4-ton, 4x4, M201, and M201B1 (signal corps) V41/GT.	3.48	4.23	4.48	3	4	4
Truck, maintenance, earth boring, machine and pole setter, 2 1/2-ton, 6x6, V18A1MTQ.	8.58	9.77	11.77	8	9	11
Truck, maintenance, telephone construction and maintenance, 2 1/2-ton, 6x6, V17A/MTQ.	8.28	9.42	11.42	8	9	11
Truck, maintenance, repair shop, 2 1/2-ton, 6x6, M46 chassis	-----	9.56	9.56	--	8	8
Truck, stake, bridge transport, 5-ton, 6x6, M139	13.2	21.0	21.0	10	18	18
Truck, stake and platform, 1 1/2-ton, 4x2	2.84	4.34	6.23	3	4	7
Truck, tank, gasoline, 2 1/2-ton, 6x6, 1200-gal., M49, and M49C ..	6.95	9.63	10.88	6	8	10

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Truck, tank, gasoline, 2 1/2-ton, 6x6, 1200-gal., M217 and M217C	7.17	9.85	11.35	6	9	10
Truck, tank, gasoline, 6x6, 2000 gal	11.91	17.91	17.91	10	18	18
Truck, tank, fuel servicing, 2500-gal., 4x4, XM559E1 (GOER)	14.10	23.87	23.87	12	22	22
Truck, tank, fuel servicing, 5000-gal., 4x4, XM438E2 (GOER)	19.24	35.87	35.87	--	--	--
10' Span	--	--	--	22	46	46
Spans over 50'	--	--	--	16	30	30
Truck, tank, water, 2 1/2-ton, 6x6, 700-gal	5.96	8.63	8.63	6	8	8
Truck, tank, water, 2 1/2-ton, 6x6, 1000-gal., M50	7.52	10.19	11.84	7	8	11
Truck, tank, water, 2 1/2-ton, 6x6, 1000-gal., M222	7.05	8.98	11.48	6	8	10
Truck, tractor, 2 1/2-ton, 6x6, M48	5.92	--	--	6	--	--
Truck, tractor, 2 1/2-ton, 6x6, M221	6.05	--	--	5	--	--
Truck, tractor, 2 1/2-ton, 6x6, M275	5.80	--	--	5	--	--
Truck, tractor, 5-ton, 6x6, M52 and M52A1	9.72	--	--	8	--	--
Truck, tractor, 5-ton, 4x2, federal model 45M2	4.90	--	--	4	--	--
Truck, tractor, 5-ton, 4x2, international-harvester model L-201	5.11	--	--	5	--	--
Truck, tractor, 5-ton, 4x2, international-harvester model R-202	5.12	--	--	5	--	--
Truck, tractor, 10-ton, 6x6, M123, M123C	16.12	--	--	14	--	--
Truck, tractor, 10-ton, 8x8, XM191	17.18	--	--	15	--	--
Truck, tractor, 12-ton, 6x6, M26A1	24.45	--	--	28	--	--
Truck, tractor, 25-ton, M523E2	20.49	--	--	18	--	--
Truck, tractor, 15-ton, 8x8, XM194E1	24.08	--	--	20	--	--
Truck, tractor, 15-ton, 8x8, XM194E2 and E3	24.22	--	--	21	--	--
Truck, tractor, 15-ton, 8x8, XM194E4	26.30	--	--	23	--	--
Truck, tractor, wrecker, 5-ton, 6x6, M246	16.42	22.42	24.42	15	20	23
Truck, van, expansible, 2 1/2-ton, 6x6, M292	10.80	12.80	12.80	--	11	11
Truck, van, expansible, 5-ton, 6x6, M291	12.75	15.25	20.25	11	14	19
Truck, van, shop, 2 1/2-ton, M109, M109C and M109D	7.62	10.29	11.37	7	9	10
Truck, van, shop, 2 1/2-ton, M220, M220C and M220D	7.54	10.22	11.47	7	9	10
Truck, wrecker, crane, 2 1/2-ton, 6x6, M108	9.89	10.37	11.82	6	9	11
Truck, wrecker, crane, 2 1/2-ton, 6x6, XM519	7.41	8.91	8.91	6	8	8
Truck, wrecker, light, 2 1/2-ton, 6x6, M60	11.98	12.73	13.73	11	12	13
Truck, wrecker, medium, 5-ton, 6x6, M62	17.01	20.51	23.01	16	21	23
Truck, wrecker, medium, 5-ton, M543A2	17.33	17.33	17.33	17	17	17
Truck, wrecker, 10-ton, 4x4, XM553 (GOER)	19.42	23.93	23.93	17	22	22
Truck, wrecker, 20-ton, 4x4, XM554 (GOER)	28.80	33.33	33.33	--	--	--
10' span	--	--	--	39	43	43
Spans over 50'	--	--	--	24	28	28

TOWED VEHICLES

a. Artillery.

Gun, antiaircraft artillery, towed, 75mm, weapons system, M51	9.64	9.64	--	8	8
Gun, antiaircraft artillery, towed, 90mm, M2, mount 90mm, M2	16.15	16.15	--	16	16
Gun, antiaircraft artillery, towed, 90mm, M118	4.15	4.15	--	5	5
Gun, antiaircraft artillery, towed, 120mm, M1 with mount 120mm, M1 and M1A1.	30.75	30.74	--	38	38
Gun, field artillery, towed, 4.5-inch	6.70	6.70	--	9	9
Gun, field artillery, towed, 155mm, M59	13.85	13.85	--	14	14
Gun, field artillery, towed, 8-inch, tlr mount M1A1 (wagon transport M1A1).	26.32	26.32	--	24	24
Howitzer, light, towed, 105mm, M101 or M101A1	2.49	2.49	--	4	4
Howitzer, medium, towed, 155mm, M114 and M114A1	6.44	6.44	--	9	9
Howitzer, medium, towed, 155mm, auxiliary propelled, M123A1	6.75	6.75	--	9	9
Howitzer, heavy, towed, 8-inch, M115	14.80	14.80	--	15	15
Howitzer, heavy, towed, 240mm, M1, wagon transport M2A1	23.86	23.86	--	21	21
Howitzer, heavy, towed, 240mm, M1 or gun field artillery, towed, 8-inch, M2 on carriage transport, wagon M3A1.	25.55	25.55	--	21	21

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
b. Trailers.						
Trailer, ammunition, 1 1/2-ton, 2-whl, M332	1.40	2.90	2.90	2	4	4
Trailer, ammunition, 2-ton, 2-whl, M10	1.40	3.40	3.40	2	5	5
Trailer, ammunition, 4-ton, 2-whl, M21 (Oneida, Trailmobile)	2.65	6.65	6.65	4	9	9
Trailer, ammunition, 8-ton, 4-whl, M23	5.00	13.00	13.00	5	11	11
Trailer, basic utility, pole type, 2 1/2-ton, 2-whl	1.20	3.70	3.70	2	5	5
Trailer, bolster, 2 1/2-ton, 2-whl	1.10	3.60	3.60	2	5	5
Trailer, bolster, pole handling, 3 1/2-ton, 2-whl, M271 and M271A1.	1.21	4.71	4.17	2	7	7
Trailer, bolster, 4-whl, special tandem 7- to 14-ton (4DT), Eidel Mfg Co.	3.60	17.60	17.60	4	21	21
Trailer, bomb, 2-ton, 4-whl, M143 and M143A1	3.20	5.20	5.20	3	5	5
Trailer, bomb, 2 1/2-ton, 3-whl, M5 (Oneida)	1.60	4.10	4.10	2	5	5
Trailer, cable reel, 3 1/2-ton, 2-whl, M310 (Signal Corps Model K-37-B).	1.26	4.76	4.76	1	7	7
Trailer, cargo, 1 1/2-ton, 2-whl, M104, M104A1 and M104A2	1.36	2.86	4.11	2	4	6
Trailer, cargo, 1 1/2-ton, 2-whl, M105, M105A1 and M105A2	1.32	2.82	3.57	2	4	6
Trailer, clamshell bucket, 3-ton, Gramma Model M-16	1.22	4.12	4.12	2	5	5
Trailer, firefighting pumper, Sabre Model TT 2000	4.85	-----	-----	6	--	--
Trailer, flat-bed, 7-ton, LaCrosse Model CTP7F, FSN 2230-255-9190	5.67	12.67	19.67	7	15	24
Trailer, flat-bed, 7-ton, LaCrosse Model CTP7F, FSN 2330-255-9191	5.67	12.67	12.67	6	15	15
Trailer, flat-bed, 4-whl, special tandem, 10-ton, for cranes shovel attachment.	5.58	15.58	15.58	6	17	17
Trailer, flat-bed, 10-ton, 4 Decal Medship Wheels, FSN 2330-377-0389.	5.63	15.63	15.63	6	18	18
Trailer, flat-bed, 10-ton, 4-whl, M345, FSN 2330-200-1737	5.63	15.63	18.63	6	18	20
Trailer, flat-bed, Guided Missile, M261	3.85	5.47	5.47	4	5	5
Trailer, low-bed, 8-ton, Fontaine Model T8-105	4.83	12.83	12.83	4	12	12
Trailer, low-bed, 8-ton, Fruehauf Model CPT-8 Special	4.76	12.50	12.50	4	12	12
Trailer, low-bed, 8-ton, Jahn Model, LKS-408	3.80	11.80	11.80	4	12	12
Trailer, low-bed, 8-ton, Hobbs Model F-1386	4.89	12.89	12.89	4	13	13
Trailer, low-bed, 8-ton, LaCrosse Model DF 4C-8F	4.83	12.83	12.83	4	14	14
Trailer, low-bed, 60-ton, Rodgers Model D-60-DS-5	17.00	-----	77.00	13	--	110
Trailer, low-bed, 60-ton, Rogers Model DW-60-LS-6	14.06	-----	79.06	10	--	123
Trailer, low-bed, 60-ton, Rogers Model D-60-DS-7	16.35	-----	76.35	12	--	117
Trailer, low-bed, 60-ton, Steel Products, Model Great Dane	15.58	-----	75.58	10	--	130
Trailer, low-bed, antenna mtd, M260 and M260A1	2.57	4.95	4.95	2	4	4
Trailer, low-bed, guided missile, 7-ton, 4-whl, XM529	7.22	13.80	13.80	6	12	12
Trailer, tank, 6-ton, 1500-gal., VIC Model 72, FSN 2330-294-6302.	10	-----	11.10	4	--	10
Trailer, tank, water, 1 1/2-ton, 2-whl, 400-gal., M106, M106A1, M106A2, M107, M107A1, M107A2 and M149.	1.25	2.97	2.97	2	4	4
Trailer, transporter, 45-ton, 12-whl, M9	10.08	-----	55.08	8	--	82
Trailer, van, shop, folding sides, 1 1/2-ton, 2-whl, M448	1.48	2.98	3.73	2	4	6
Trailer, van, launching control, M262	3.40	6.20	6.20	4	6	6
Trailer, van, radar tracking control, M258	3.43	5.97	5.97	3	5	5
Trailer, van, director station, M259	3.53	6.31	6.31	3	5	5
Trailer, van, fire control, 2-ton, 4-whl, M244	3.56	6.04	6.04	4	6	6
Transporter, liquid rolling wheel	1.07	4.27	4.27	1	6	6
Transporter, liquid rolling wheel (2 in tandem)	2.14	8.42	8.42	2	7	7
Transporter, liquid rolling wheel (3 in tandem)	3.21	12.63	12.63	2	10	10
Transporter, liquid rolling wheel (4 in tandem)	4.28	16.83	16.83	3	12	12
c. Semitrailers						
Semitrailer, LOX, 9-ton, 2-whl	8.82	17.82	17.82	7	16	16

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Semitrailer, low-bed, crane, 7-ton, M6	3.91	-----	12.41	3	--	11
Semitrailer, low-bed, wrecker, 12-ton, 4-whl, M270 and M270A1 ..	8.75	20.75	28.75	8	17	24
Semitrailer, low-bed wrecker, 12-ton, 4-whl, M269 and M269A1 ..	7.10	19.10	27.10	6	17	23
Semitrailer, low-bed, 15-ton, 4-whl, M172	7.75	-----	22.75	6	--	19
Semitrailer, low-bed, 25-ton, 4-whl, M172A1	7.43	32.43	37.43	7	29	36
Semitrailer, low-bed, 60-ton, 8-whl, M162A1	7.43	32.42	37.43	6	28	36
Semitrailer, maintenance weapon, mechanical unit M457	-----	6.92	6.92	--	6	6
Semitrailer, maintenance weapon, electrical unit M458	-----	7.20	7.20	--	6	6
Semitrailer, maintenance weapon, connecting unit M459	-----	7.20	7.20	--	6	6
Semitrailer, mobile sawmill, Corinth Machinery Co Model, Saw Mobile No. 58.	-----	19.15	19.15	--	18	18
Semitrailer, repair parts, shopvan, 6-ton, 4-whl, semitrailer chas- sis, M295A1.	-----	8.6	8.6	--	11	11
Semitrailer, stake and platform, 5-ton, 2-whl, Olson Model 516 ..	3.32	8.32	10.32	3	8	10
Semitrailer, stake, 6-ton, 2-whl, M118 and M118A1	3.55	9.55	11.65	4	8	11
Semitrailer, stake, 12-ton, 4-whl, M127, M127A1 and M127A1C ..	7.20	19.20	25.20	8	23	30
Semitrailer, stake, 12-ton, 4-whl, M127A2C	7.02	19.02	25.02	7	22	29
Semitrailer, tank, alcohol, 300-gal., 2-whl, M388	4.15	12.15	12.15	5	13	13
Semitrailer, tank, 6-ton, 1500-gal., dual whls, Little Ford Model Jan-T-505.	4.0	-----	10.0	4	9	9
Semitrailer, tank, 6-ton, 1500-gal., dual whls, Columbian Steel Tank M1944.	3.3	-----	9.55	3	8	8
Semitrailer, tank, gasoline, 6-ton, 2-whl, 2000-gal., M30, Progress Model ST62M.	3.38	-----	9.48	3	--	9
Semitrailer, tank, gasoline, 12-ton, 4-whl, 5000-gal., M131, M131A1 and M131A2.	7.42	17.23	22.69	7	16	21
Semitrailer, tank, fuel-servicing, 2-whl, 2000-gal., Type F-28, Heil Co.	4.00	-----	10.00	4	--	9
Semitrailer, tank, water, 2000-gal., 2-whl, M586	3.21	-----	11.51	4	--	14
Semitrailer, tank transporter, 40-ton, 8-whl, M15	21.19	61.19	61.19	15	53	53
Semitrailer, tank transporter, 45-ton, 8-whl, M15A1	21.18	66.18	66.18	16	59	59
Semitrailer, tank transporter, 50-ton, 8-whl, M15A2	21.30	71.30	71.30	16	78	78
Semitrailer, van, cargo, 12-ton, 4-whl, M128A1 and M128A1C ..	7.74	19.74	25.74	7	18	23
Semitrailer, van, cargo, 12-ton, 4-whl, M128A2C	7.70	19.70	25.70	8	23	30
Semitrailer, van, cargo, 6-ton, 2-whl, M118 and M118A1	3.57	9.57	11.67	5	9	11
Semitrailer, van, cargo, 6-ton, 2-whl, M119 and M119A1	3.59	9.59	11.69	5	9	11
Semitrailer, van, electronic, 3-ton, 2-whl, M348A1 and M348A2 ..	4.32	7.32	9.32	5	10	11
Semitrailer, van, electronic, 6-ton, 2-whl, M348A2C, M348A2F and M348A2G.	4.38	9.38	10.38	5	10	11
Semitrailer, van, electronic, 6-ton, 2-whl, M373A2C	4.85	9.58	10.85	5	10	11
Semitrailer, van, refrigerator, 7 1/2-ton, 2-whl, M349 and M349A	4.30	-----	11.80	5	--	13
Semitrailer, van, shop, 6-ton, 2-whl, M146 and M146C	3.48	9.67	11.77	4	9	10
Semitrailer, van, supply, 12-ton, 4-whl, M129A1 and M129A1C ..	8.01	20.01	26.01	7	18	23
Semitrailer, van, supply, 12-ton, 4-whl, M129A2C	7.80	19.80	25.80	8	23	30

CONSTRUCTION EQUIPMENT

Bin, aggregate loading, trl-mtd, GED, 30-ton, Iowa Model 30-T ..	5.93	-----	-----	5	--	-
Bin, aggregate loading, trl-mtd, GED, 30-ton, Universal Model PB-20.	5.86	-----	-----	5	--	--
Bin, aggregate loading, trl-mtd, GED, 30-ton, Pioneer Model 220	8.57	-----	-----	7	--	--
Compressor, air, GED, trk mtd, 80CFM, Clark model HO-6-5C1, FSN 4310-555-1634.	-----	9.25	9.25	--	8	8
Compressor, air, rotary, DED, whl-mtd, 315 CFM, Ingersoll- Rand Model DR 315, FSN 4310-270-3332.	-----	4.04	4.04	--	4	4
Compressor, air, DED, trl-mtd, 315 CFM, LeRoi Model 315D2-C ..	-----	4.36	4.36	--	4	4

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Compressor, air, GED, whl-mtd, 600 CFM, Ingersoll-Rand Model DR-600.	----	5.59	5.59	--	6	6
Compressor, reciprocating, DED, 500 CFM, whl-mtd, Worthington Model Blue Brute 500.	----	5.68	5.68	--	6	6
Compressor, reciprocating, power-driven, 80 CFM, 5000 psi, trk-mtd, M45 chassis, Joy Model 8-HGC-3-MS-1.	----	9.21	9.21	--	8	8
Compressor, reciprocating, power-driven, 80 CFM, 5000 psi, trk-mtd, M45 chassis, Joy Model 80-HGC2-MS-1	----	9.21	9.21	--	8	8
Compressor, reciprocating, power-driven, GED, 80 CFM, 5000 psi, trk-mtd, M45 chassis, Clark Model HO-6-5G.	----	9.25	9.25	--	8	8
Compressor, reciprocating, power-driven, 210 CFM, Davy Model 210WDS, FSN 4310-272-8128.	----	7.92	7.92	--	7	7
Compressor, power-driven, GED, 210 CFM, 100 psi, trk-mtd, Joy Model RPA-210 GD3-MS-1.	----	7.35	7.35	--	6	6
Compressor, reciprocating, power-driven, 210 CFM, 100 psi, trk-mtd, LeRoi Model 210-G2.	----	8.04	8.04	--	7	7
Compressor, reciprocating, air, GED, trk-mtd, 210 CFM, 100 psi, LeRoi Model 210G1.	----	7.65	7.65	--	7	7
Compressor, rotary, power-driven, GED, 210 CFM, 100 psi, trk-mtd, M45 chassis, Harris Model J-210.	----	7.53	7.53	--	7	7
Compressor, rotary, power-driven, whl-mtd, 600 CFM, 100 psi, Ingersoll-Rand Model DR 600 WTRZD.	----	5.62	5.62	--	6	6
Conversion-storage-charging unit, carbon-dioxide, Cardox Model FE 34365.	----	16.40	16.40	--	16	16
Conversion unit, carbon-dioxide, semitrailer-mtd, Girdler Model 131-4910.	----	19.33	19.33	--	17	17
Conveyor, belt, whl-mtd, electric, 300 tons per hour, 50-foot, Barber-Greene Model PG-70, FSN 3910-790-2175.	----	----	4.82	--	--	6
Cooling tower, liquid semitrailer-mtd, Badger Model CT-1, FSN 3655-606-0820.	----	----	8.22	--	--	7
Crane-shovel, basic unit, crawler-mtd, GED, 10-ton, 3/4 cu yd, American Hoist Model 375-BC.	----	18.7	18.7	--	14	14
Crane-shovel, basic unit, crawler-mtd, DED, 40-ton, 2 cu yd, Baldwin-Lima-Hamilton Model 802.	----	66.25	66.25	--	--	--
Spans under 20 feet	----	----	----	--	153	153
Spans over 20 feet	----	----	----	--	81	81
Crane-shovel, basic unit, crawler-mtd, GED, 10-ton, 3/4 cu yd, Baldwin-Lima-Hamilton Model 34.	----	16.58	16.58	--	22	22
Crane-shovel, basic unit, crawler-mtd, DED, 40-ton, 2 cu yd, Bucyrus-Erie Model 51-B.	----	66.00	66.00	--	--	--
Spans under 20 feet	----	----	----	--	134	134
Spans over 20 feet	----	----	----	--	79	79
Crane-shovel, basic unit, crawler-mtd, GED, 5-ton, 3/4 cu yd, Bucyrus-Erie Model 22-B.	----	19.17	19.17	--	19	19
Crane-shovel, basic unit, crawler-mtd, GED, 10-ton, 3/4 cu yd, Byers Model 83.	----	19.8	19.8	--	19	19
Crane-shovel, basic unit, crawler-mtd, DED, 40-ton, 2 cu yd, Harnischfeger Model 855-BG.	----	40.38	40.38	--	56	56
Crane-shovel, basic unit, crawler-mtd, DED, 40-ton, 2 cu yd, Harnischfeger Model 855-RG3.	----	50.51	50.51	--	58	58
Crane-shovel, basic unit, crawler-mtd, DED, 35-ton, 2 cu yd, Harnischfeger Model 855-B.	----	53.2	53.2	--	--	--
Spans under 20 feet	----	----	----	--	72	72
Spans over 20 feet	----	----	----	--	56	56

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Crane-shovel, basic unit, crawler-mtd, GED, 40-ton, 2 cu yd, Wtzd to 65° F, Harnischfeger Model 855-BG-2.	----	48.16	48.16	--	--	--
Spans under 20 feet	----	----	----	--	58	58
Spans over 20 feet	----	----	----	--	50	50
Crane-shovel, basic unit, crawler-mtd, GED, 5-ton, 1/2 cu yd, Insley Model E-12.	----	12.00	12.00	--	11	11
Crane-shovel, basic unit, crawler-mtd, DED, 40-ton, 2 cu yd, Manitowoc Model 3000-B.	----	58.50	58.50	--	--	--
Spans under 20 feet	----	----	----	--	101	101
Spans over 20 feet	----	----	----	--	69	69
Crane-shovel, basic unit, crawler-mtd, 10-ton, 3/4 cu yd, Thew Model TL-25K.	----	16.0	16.0	--	15	15
Crane-shovel, basic unit, crawler-mtd, DED, 35-ton, 2 cu yd, Thew Model L-820 and L-820-J.	----	50.35	50.35	--	55	55
Crane-shovel, basic unit, crawler-mtd, GED, 10-ton, 3/4 cu yd, Unit Model 1020-YD.	----	17.5	17.5	--	16	16
Crane-shovel, basic unit, trk-mtd, Ged, 20-ton, 3/4 cu yd, Baldwin-Lima-Hamilton Model 34-T.	----	28.25	28.25	--	27	27
Crane-shovel, basic unit, trk-mtd, 10-ton, Bay City Model 150M ..	----	18.92	18.91	--	18	18
Crane-shovel, basic unit, trk-mtd, GED, 20-ton, 3/4 cu yd, Garwood Model M-20-B.	----	28.25	28.25	--	34	34
Crane-shovel, basic unit, trk-mtd, GED, 20-ton, 3/4 cu yd, Garwood Model M-20-A(F).	----	28.05	28.05	--	34	34
Crane-shovel, basic unit, trk-mtd, GED, 20-ton, 3/4 cu yd, Koehring Model 304.	----	27.6	27.6	--	32	32
Crane-shovel, basic unit, trk-mtd, GED, 20-ton, 3/4 cu yd, Link Belt Model HC-70.	----	28.25	28.25	--	25	25
Crane-shovel, basic unit, trk-mtd, GED, 20-ton, 3/4 cu yd, Quick-Way Model M202, FSN 3810-820-0698.	----	25.39	25.39	--	25	25
Crane-shovel, basic unit, trk-mtd, DED, 20-ton, 3/4 cu yd, Quick-Way Model M-200.	----	23.5	23.5	--	25	25
Crane-shovel, basic unit, trk-mtd, GED, 3-ton, 3/8 cu yd, Quick-Way Model N383AB.	----	9.15	9.15	--	8	8
Crane-shovel, basic unit, trk-mtd, GED, 3-ton, 3/8 cu yd, Schield Bantam Model ABM-53.	----	9.27	9.27	--	8	8
Crane-shovel, basic unit, trk-mtd, GED, 20-ton, 3/4 cu yd, Thew Model MC-416.	----	26.55	26.55	--	28	28
Crane-shovel, basic unit, trk-mtd, GED, 10-ton, 1/2 cu yd, Thew Model MC-254.	----	19.87	19.87	--	20	20
Crane-shovel, basic unit, trk-mtd, GED, 10-ton, 1/2 cu yd, Thew Model E-6610.	----	18.05	18.05	--	18	18
Crane-shovel, basic unit, trk-mtd, GED, Unit Model 1220-CE ..	----	26.25	26.25	--	31	31
Crane-shovel, basic unit, trk-mtd, GED, 10-ton, 1/2 cu yd, Wayne Crane Model 40.	----	19.20	19.20	--	19	19
Crane-shovel, basic unit, whl-mtd, DED, 20-ton, 3/4 cu yd, rough terrain.	----	28.50	28.50	--	30	30
Crane, 1/2 cu yd, 7-ton, airdroppable, self-propelled, 4x4, whl-mtd, Garwood and Koehring Model 7.	----	8.12	8.12	--	8	8
Crane, whl-mtd, DED, 5-ton, 3/8 cu yd, air transportable, rough terrain.	----	14.68	14.68	--	15	15
Crusher, jaw, diesel and electric, 75 TPH, Eagle Model 5157	----	36.7	36.7	--	37	37
Crusher, jaw, GED, whl-mtd, 4-whl, 15 TPH, Iowa Model AB-1424SP-15T.	----	7.25	7.25	--	8	8
Crusher, jaw, GED, crawler-mtd, 200-400 TPH, 4-in. size, Iowa Model 2-A.	----	16.45	16.45	--	15	15

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Crusher, roll, diesel and electric, 75 TPH, whl-mtd, Eagle Model 5230B.	----	30.72	30.72	--	27	27
Crushing and screening unit, GED, whl-mtd, 6-whl, 40 to 140 TPH, Pioneer Model 42-VA.	----	28.2	28.2	--	25	25
Crushing and screening unit, GED, crawler-mtd, 100 to 190 TPH, Pioneer Model 54-VA.	----	38.54	38.54	--	58	58
Crushing and screening unit, GED, crawler-mtd, 100 to 190 TPH, Iowa Model 2-A.	----	17.15	17.15	--	15	15
Crushing, screening, and washing unit, DED, whl-mtd, 6-whl, 40 to 250 TPH, Iowa Model DJ-50.	----	31.94	31.94	--	26	26
Crushing, screening, and washing unit, DED, whl-mtd, 40 to 250 TPH, Pioneer Model 33R Triplex.	----	31.3	31.3	--	39	39
Crushing, screening, and washing unit, DED, whl-mtd, 6-whl, 40 to 250 TPH, Universal Model 1830-CWL.	----	32.62	32.62	--	45	45
Dehydrator, sand, tlr-mtd, Pioneer Model 1833	----	3.42	3.42	--	6	6
Dehydrator, sand, tlr-mtd, Universal Model 20PW	----	3.73	3.73	--	6	6
Dehydrator, sand, tlr-mtd, Pioneer Model 2220 SDE	----	7.56	7.56	--	7	7
Dehydrator, sand, tlr-mtd, Pioneer Model P-300W	----	9.35	9.35	--	9	9
Dehydrator, sand, 120 tp 150 TPH, Iowa Model 5022E	----	8.75	8.75	--	7	7
Distributor, bituminous material, tank type, GED, trk-mtd, 800-gal., Etnyre Model MIL-D32.	11.20	15.20	15.20	10	15	15
Distributor, bituminous material, tank type, GED, trk-mtd, 800-gal., General Steel Tank Model SCD	11.72	15.72	15.72	10	15	15
Distributor, bituminous material, tank type, GED, trk-mtd, 800-gal., Etnyre Model MXRE D-30.	11.70	15.20	15.20	10	15	15
Distributor, bituminous material, tank type, 1250-gal., Etnyre Model MX Style RE.	10.69	----	15.1	10	--	14
Distributor, water, tank type, GED, trk-mtd, 1000-gal., force feed, Municipal Model WD-1000.	10.05	14.22	14.22	9	13	13
Distributor, water, tank type, trk-mtd, 1000-gal., VIC Model M73A.	10.35	14.52	14.52	9	13	13
Distributor, water, tank type, trk-mtd, 1000-gal., force feed, MacLeod Model W-IM3.	10.31	13.31	13.31	9	14	14
Distributor, water, tank type, trk-mtd, 1000-gal., force feed, MacLeod Model 3-IM5.	10.30	14.47	14.47	9	14	14
Distributor, water, tank type, trk-mtd, 1000-gal., force feed, Butler Model 6743.	10.30	14.47	14.47	9	14	14
Distributor, water, tank type, trk-mtd, 1000-gal., ROSCO Model MOE.	10.00	14.17	14.17	9	13	13
Distributor, water, tank type, trk-mtd, 1000-gal., ROSCO Model MME.	9.60	13.77	13.77	8	12	12
Ditching machine, DED, whl-mtd, ladder type, Unit Rig and Equip Model 4262.	----	18.0	18.0	--	19	19
Drier aggregate, GED, tlr-mtd, 2-whl, 10 to 25 TPH, Barber Greene Model 830.	----	5.13	5.13	--	9	9
Drier aggregate, DED, tlr-mtd, 80 to 120 TPH, Barber Greene Model 837.	----	18.1	18.1	--	17	17
Dust collecting machine, paving materials, DED, 22,000 CFM, semitlr-mtd, Barber Greene Model 857.	----	10.31	10.31	--	11	11
Generating and charging plant, carbon dioxide, semitlr-mtd, Girdler Model 32-4027, FSN 3655-390-8562.	----	24.50	24.50	26	26	26
Generating and charging plant, carbon dioxide, semitlr-mtd, Gridler Model 32-4176, FSN 3655-554-4558.	----	24.0	24.0	23	23	23
Generating and charging plant, hydrogen-carbon dioxide, semitlr-mtd, Electric Heating Equipment Model H2-CO2, FSN 3655-288-2993.	----	24.47	24.47	--	23	23

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Generating and charging plant, oxygen-nitrogen, semitr-mtd, Air Products Model A2.	----	15.0	15.0	--	17	17
Generator, carbon dioxide, semitr-mtd, Electric Gridler Model 32-4027.	----	24.01	24.00	--	25	25
Graduation control unit, aggregate tlr-mtd, Barber Greene Model 866	----	15.28	15.28	--	12	12
Grader, road, motorized, DED, Austin-Western Model 99-H	----	10.7	10.7	--	9	9
Grader, road, motorized, DED, Caterpillar Model 12	----	12.5	12.5	--	10	10
Grader, road, motorized, DED, Caterpillar Model 212	----	7.46	7.46	--	6	6
Grader, road, motorized, Gallion Model 118	----	12.70	12.70	--	10	10
Grader, road, motorized, DED, Huber-Warco Model 4D	----	12.59	12.59	--	11	11
Grader, road, motorized, DED, LeTourneau-Westinghouse Model 220.	----	7.98	7.98	--	7	7
Grader, road, motorized, Riddell Model 4D-100	----	12.41	12.41	--	10	10
Grader, road, towed, Adams Model 124S	----	5.93	5.93	--	5	5
Heater, bitumen, GED tlr-mtd, steam, Williams Bros Model SG-52TA.	3.13	----	----	5	--	--
Loader, scoop-type, GED, 1 1/2 cu yd, Clark Model 85-AM	7.35	----	10.35	9	--	14
Loader, scoop-type, DED, 2 1/2 cu yd, 4-whl, Hough Model H-90M, FSN 3805-803-2672.	14.20	----	18.2	15	--	30
Loader, scoop-type, DED, 4-whl, 2 1/2 cu yd, Clark Model 175A-M23.	14.41	----	19.00	16	--	22
Loader, bucket-type, DED, crawler, mtd, Haiss Model 77-PC	11.5	----	----	12	--	--
Loader, belt-type, GED, crawler, self-propelled, 10 to 20 cu yd per min, Barber Greene Model 538B.	7.84	----	----	11	--	--
Mixer, bituminous material, DED, 110-200 TPH, tlr-mtd, Barber Green Model 848.	15.70	----	----	16	--	--
Mixer, concrete, tlr-mtd, Construction Model 16-S	3.00	----	----	3	--	--
Mixer, concrete, tlr-mtd, liquid-cooled, 16 cu ft, Gallion Model 16S-SCE.	3.65	----	----	4	--	--
Mixer, concrete, tlr-mtd, Ransome Model 14SU	3.00	----	----	3	--	--
Mixer, rotary tiller, DED, self-propelled, Seaman Model TP-84M	5.74	----	----	5	--	--
Paving machine, bituminous material, GED, Barber Green Model 879-A.	12.12	----	----	21	--	--
Paving machine, bituminous material, GED, Barber Greene Model 879-B.	11.25	----	----	14	--	--
Power unit, gasoline, whl-mtd, Minneapolis-Moline Model 1210-12A.	7.19	----	----	8	--	--
Roller, motorized, Buffalo-Springfield Model KT-24B, FSN 3895-187-2645.	8.75	----	----	10	--	--
Roller, motorized, GED, 3-whl, 9-ton, Buffalo-Springfield Model KX-16-C2.	6.30	----	----	--	--	--
Roller, motorized, Buffalo-Springfield Model KT-16B, FSN 3895-194-8536.	6.00	----	----	7	--	--
Roller, motorized, GED, 5- to 8-ton, Gallion Model 3T9G	10.76	----	----	12	--	--
Roller, motorized, GED, 5- to 8-ton, Gallion Model T-5G	5.90	----	----	6	--	--
Roller, motorized, road, Gallion Model T-8G, FSN 3895-290-4993	8.84	----	----	11	--	--
Roller, motorized, DED, 8- to 12-ton, Gallion Model Chief	10.02	----	----	11	--	--
Roller, motorized, GED, 10- to 20-ton, Gallion Model Chief CG	10.60	----	----	13	--	--
Roller, motorized, GED, 3-whl, 10-ton, Gallion Model Chief Rollo-Matic.	10.83	----	----	13	--	--
Roller, towed, pneu tire, 4-whl, 7-ton, Shovel Supply Model RT-100CE.	6.95	----	----	10	--	--
Roller, towed, pneu tire, 7 1/2-ton, Grace Model Wltr	7.25	----	----	10	--	--
Rooter, towed, Southwest Model RH-3	6.62	----	----	10	--	--

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Rooter, towed, LeTourneau Model LW-H-3	3.82	----	-----	6	--	--
Saw Mill, circular, DED, tlr-mtd, Jackson Lumber Harvester Model RMS.	4.80	----	-----	7	--	--
Scraper, earthmoving, towed, 7.2 cu yd, Heil Model OC-9, FSN 3805-378-9805.	7.70	14.70	14.70	7	14	14
Scraper, earthmoving, towed, 7.5 cu yd, Be-Ge Model 6595, FSN 3805-554-5051.	7.06	14.06	14.06	6	14	14
Scraper, earthmoving, towed, 7.5 cu yd, Murry Model AR88M, FSN 3805-683-9126.	4.9	13.81	13.81	4	15	15
Scraper, earthmoving, towed, 12 cu yd, Woolrich Model OS-122-A, FSN 3805-691-6161.	12.10	27.10	27.10	9	37	37
Scraper, earthmoving, towed, 12 cu yd, LeTourneau-Westinghouse Model LPO 3805-351-9542.	9.75	21.75	21.75	8	26	26
Scraper, earthmoving, towed, 13.5 cu yd, Southwest Welding Model S-152, FSN 3805-691-6132.	12.00	28.00	28.00	9	37	37
Scraper, earthmoving, towed, 18 cu yd, Curtiss-Wright Model CWT-18-M.	15.45	40.45	40.45	16	77	77
Scrubber and washer, aggregate, Iowa Model 720	-----	17.69	17.69	--	16	16
Scrubber and washer, aggregate, GED, whl-mtd, 80 to 120 TPH, Pioneer Model Log Washer.	-----	23.6	23.6	--	21	21
Snow removal unit, GED, rotary, trk-mtd, 7 1/2-ton, 4x4, KLAUR Model TU-3.	-----	11.32	11.32	--	10	10
Snowplow, trk-mtd, Wausau Model M-1123, mtd on Oskosh Model WT2206.	-----	16.10	16.10	--	23	23
Tank, storage, liquid, argon-nitrogen-oxygen, semi-trl-mtd, Cambridge Model 217-30.	-----	-----	-----	7	--	16
Tractor, wheeled, Industrial, Case Model LA1, FSN 2420-190- 0347.	-----	6.25	6.25	--	8	8
Tractor, whl, Industrial, DED, Caterpillar Model DW-20M, FSN 2420-200-1297.	-----	24.82	24.82	--	34	34
Tractor, whl, Industrial, DED, LeTourneau-Westinghouse Model Super C Tournatractor.	-----	16.24	16.24	--	19	19
Tractor, whl, Industrial, DED, LeTourneau-Westinghouse Model Super C Tournadozer.	-----	17.30	17.30	--	19	19
Tractor, whl, Industrial, MRS Model 72AGT	-----	7.88	7.88	--	9	9
Tractor, whl, DED, MRS Model 100, FSN 2420-792-6163	-----	-----	-----	--	8	8
Tractor, whl, Industrial, MRS Model 125	-----	10.75	10.75	--	10	10
Tractor, whl, Industrial, DED, air transportable, MRS Model 150 AGT.	-----	7.87	7.87	--	8	8
Tractor, whl, Industrial, DED, air transportable, MRS Model 150.	-----	17.65	17.65	--	21	21
Tractor, whl, Industrial, DED, MRS Model 190	-----	15.39	15.39	--	17	17
Tractor, whl, Industrial, DED, Westphall Model SWD 300	-----	21.20	21.20	--	33	33
Tractor, full-tracked, low-speed, DED, Allis-Chalmers Model HD6M.	-----	8.00	8.00	--	8	8
Tractor, full-tracked, low-speed, DED, Caterpillar Model 933	-----	7.99	7.99	--	9	9
Tractor, full-tracked, low-speed, DED, 44-in. min ga, Caterpillar Model D-4.	-----	7.0	7.0	--	9	9
Tractor, full-tracked, low-speed, DED, 60-in. min ga, Caterpillar Model D-4, FSN 2410-190-0196.	-----	7.27	7.27	--	8	8
Tractor, full-tracked, low-speed, DED, 60-in. min ga, Caterpillar Model D-4, FSN 2410-190-0020.	-----	7.50	7.50	--	9	9
Tractor, full-tracked, low-speed, DED, 60-in. min ga, Caterpillar Model D-4, FSN 2410-190-0217.	-----	7.98	7.98	--	10	10
Tractor, full-tracked, low-speed, DED, 56-in. min ga, Caterpillar Model D-6, FSN 2410-190-0049.	-----	16.31	16.31	--	21	21

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Tractor, full-tracked, low-speed, DED, 74-in. min ga, Caterpillar Model D-6, FSN 2410-185-0855.	----	9.79	9.79	--	10	10
Tractor, full-tracked, low-speed, DED, w/angle-dozer, cable PCU, winch, Caterpillar Model D-7, FSN 2410-191-0536.	----	16.25	16.25	--	19	19
Tractor, full-tracked, low-speed, DED, 74-in. min ga, Caterpillar Model D-7.						
FSN 2410-191-0532	----	12.76	12.76	--	13	13
FSN 2410-190-0339	----	16.25	16.25	--	17	17
FSN 2410-191-0537	----	16.65	16.65	--	18	18
FSN 2410-277-1280	----	17.83	17.83	--	20	20
FSN 2410-233-5746	----	17.83	17.83	--	20	20
FSN 2410-233-5749	----	16.25	16.25	--	18	18
Tractor, full-tracked, low-speed, DED, 74-in. min ga, Caterpillar Model D-7, with crane, center-revolving, Trackson Model CDT, FSN 2410-234-4603.	----	16.62	16.62	--	19	19
Tractor, full-tracked, low-speed, DED, 74-in. min ga, Caterpillar Model D-8.						
FSN 2410-223-1216	----	18.10	18.10	--	20	20
FSN 2410-618-3139	----	21.25	21.25	--	26	26
FSN 2410-268-8229	----	20.80	20.80	--	22	22
FSN 2410-267-6888	----	21.77	21.77	--	22	22
FSN 2410-233-5750	----	21.00	21.00	--	27	27
FSN 2410-233-1210	----	23.56	23.56	--	33	33
FSN 2410-223-1214	----	23.37	23.37	--	30	30
FSN 2410-233-5752	----	21.80	21.80	--	27	27
FSN 2410-542-4882	----	22.05	22.05	--	30	30
Tractor, full-tracked, low-speed, DED, 60-in. min ga, International Harvester Model TD-9, FSN 2410-190-0211.	----	5.3	5.3	--	6	6
Tractor, full-tracked, low-speed, DED, 74-in. min ga, International Harvester Model TD-18-182, FSN 2410-541-7655.	----	19.82	19.82	--	25	25
Tractor, full-tracked, low-speed, DED, International Harvester Model TD-20-200.						
FSN 2410-542-2498	----	18.67	18.67	--	25	25
FSN 2410-542-2499	----	18.70	18.70	--	24	24
Tractor, full-tracked, low-speed, DED, 78-in. min ga, International Harvester Model TD-24-241, FSN 2410-542-2337.	----	27.66	27.66	--	32	32
Tractor, full-tracked, low-speed, DED, 78-in. min ga, with bulldozer and backrip, scarifier, PCU, International Harvester Model TD-24-241, FSN 2410-542-2338.	----	27.09	27.09	--	31	31
Trailer, Dump, 11 cu yd, 4-whl, pneu tire, hopper dump, MRS Model 110AWG.	7.22	22.22	22.22	6	22	22
Trailer-tractor, dump, DED, Euclid Model 89W, with Model 71 FDT tractor, FSN 3805-261-5830.	17.90	37.90	37.90	13	31	31
Water purification unit, van, 1500 GPH, Met-Pro Model 1500-2600.	----	9.51	9.51	--	8	8
Water purification unit, van, 3000 GPH, Met-Pro Model 3000-2700	----	10.71	10.71	--	9	9
Water purification unit, tlr-mtd, 600 GPH, Met-Pro Model 600-2500.	----	2.91	2.91	--	5	5

MISSILE SYSTEMS

a. Pershing.

Carrier, missile equipment, full-tracked, XM474E2	5.95	----	----	5	--	--
Communications pack, mtd on carrier XM474E2	----	8.89	8.89	--	8	8
Erector-Launcher, mtd on carrier XM474E2	----	9.72	9.72	--	9	9
Power station and programer, mtd on carrier XM474E2	----	10.91	10.91	--	10	10
Warhead, pallet and warhead handling gear, mtd on XM474E2	----	8.16	8.16	--	8	8

Vehicle description	Weight (short tons)			Class		
	E	Loaded		E	Loaded	
		C	H		C	H
Facilities distribution, mtd on tlr, 1 1/2-ton, 2-whl, M-105A2 ----	----	2.54	2.54	--	4	4
Generator, 45-KW, mounted on tlr, 2-whl, 3 1/2-ton, MX353 ----	----	3.78	3.78	--	6	6
<i>b. Sergeant.</i>						
Launching station, 4-whl, semitlr-mtd, guided missile XM504 ----	----	8.5	8.5	--	7	7
Combined with truck, tractor, 5-ton, 6x6, M52 -----	----	18.22	18.22	--	14	14
Transport trailer, 4-whl, 6-ton, XM527 w/2 forebodies -----	----	5.11	5.11	--	4	4
Transport trailer, 4-whl, 6-ton, XM527 w/missile motor, fin and guidance. ----	----	7.74	7.74	--	6	6
Semitrailer, motor-guidance transport -----	----	7.75	7.75	--	7	7
Combined with truck, tractor, 2 1/2-ton, 6x6, M48, M221, M275. ----	----	13.80	13.80	--	10	10
Test station, organizational maintenance, AN/MSM-35 -----	----	7.75	7.75	--	6	6
Combined with truck, tractor, 2 1/2-ton, 6x6, M275 -----	----	13.55	13.55	--	10	10
Test station, field maintenance, AN/MSM-36 -----	----	7.75	7.75	--	6	6
Combined with truck tractor, 2 1/2-ton, 6x6, M275 -----	----	13.55	13.55	--	10	10
<i>c. Little John.</i>						
Handling unit, rocket, trk-mtd, 318MM, M572 -----	6.75	9.25	9.25	6	8	8
<i>d. Honest John.</i>						
Handling unit, 762mm rocket, tlr-mtd, M405 and M405A1 -----	4.31	7.31	7.31	5	7	7
Heating and tiedown unit, 762mm rocket, trk-mtd, M78 and M78A1. ----	12.43	15.39	15.39	10	14	14
Kit, 762mm rocket, XM78E1, M55 trk dual rear whl, cargo body with winch. ----	12.31	18.92	18.92	10	17	17
Launcher, 762mm rocket, trk-mtd, M289 -----	20.90	23.80	23.80	19	22	22
Launcher, 762mm rocket, trk-mtd, M386 -----	17.12	20.08	20.08	16	19	19
Trailer, rocket transporter, 762mm rocket, M329A1 and M329A2. ----	2.50	5.50	5.50	3	7	7
<i>e. Hawk.</i>						
Loader-transporter guided missile, XM501E1, XM501E2 and XM 501. ----	2.77	4.75	4.75	3	5	5
Generator, 45-KW, mtd on chassis, tlr, M200A1 -----	----	4.25	4.25	--	5	5
Radar set, pulse acquisition, tlr-mtd, AN/MPQ-35 -----	----	3.97	3.97	--	6	6
<i>f. Nike-Ajax.</i>						
Antenna-receiver-transmitter group, TGT tracking, tlr-mtd, (tlr, low-bed, antenna, mtd, M260). ----	----	5.47	5.47	--	5	5
Director station, guided missile, tlr-mtd, AN/MSA-7 and AN/MSA-17. ----	----	6.32	6.32	--	6	6
Electronic shop, tlr-mtd, M304 and M304A1 -----	----	6.59	6.59	--	6	6
Launching control group, tlr-mtd, OA-867/MSE-2 -----	----	6.00	6.00	--	6	6
Tracking station, guided missile, tlr-mtd, AN/MPA-4 -----	----	6.18	6.18	--	5	5
<i>g. Nike-Hercules.</i>						
Antenna-receiver-transmitter group, missile tracking, OA-1340/MPA, OA-1487/MPA, and OA-1487A/MPA, tlr-mtd, (antenna, tlr, M406). ----	----	6.36	6.36	--	6	6
Director station, guided missile, tlr-mtd, AN/MSA-19 -----	----	6.79	6.79	--	6	6
Electronic shop, tlr-mtd, M304 and M304A1 -----	----	6.57	6.57	--	6	6
Launching control group, guided missile, tlr-mtd, AN/MSW-4 ----	----	5.19	5.19	--	6	6
Tracking station, guided missile, tlr-mtd, AN/MPA-5 -----	----	6.42	6.42	--	5	5
Test equipment, electronic shop, field maint, tlr-mtd, AN/MPM-44, XM383. ----	----	6.50	6.50	--	6	6
Test equipment, electronic shop, field maint, tlr-mtd, AN/MPM-46, XM382. ----	----	6.50	6.50	--	6	6
COMBINATION VEHICLES						
Truck, cargo, 3/4-ton, 4x4, M37. ----	----	----	----	----	----	----
Trailer, cargo, 1/4-ton, 2-whl, M100 -----	3.24	4.24	4.24	3	4	4
Trailer, cargo, 3/4-ton, 2-whl, M101 -----	3.63	5.13	5.76	3	5	5

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Truck, cargo, 2 1/2-ton, M35.						
Trailer, cargo, 1 1/2-ton, 2-whl, M105	7.77	11.77	15.02	6	9	12
Trailer, tank, water, 400 gal., M106	7.58	11.75	14.25	6	9	12
Howitzer, light, towed, 105mm, M101	8.93	11.43	13.93	7	9	11
Trailer, cargo, 1 1/2-ton, 2-whl, M104	7.64	11.64	15.39	7	10	12
Trailer, basic utility, pole type, 2 1/2-ton, 2-whl	7.64	12.64	15.14	6	10	12
Truck, cargo, 2 1/2-ton, 6x6, M36.						
Compressor, air, tlr-mtd, 4-whl, DED, 315 CFM	13.84	16.34	18.84	10	12	15
Conveyor, belt, whl-mtd, 300 TPH, Barber Greene Model PG-70.	11.06	13.56	16.06	8	10	12
Truck, cargo, 2 1/2-ton, 6x6, M211.						
Trailer, cargo, 1 1/2-ton, 2-whl, M104	7.99	12.17	15.92	7	10	13
Trailer, cargo, 1 1/2-ton, 2-whl, M105	8.12	12.29	15.55	7	10	12
Trailer, tank, water, 400-gal., 1 1/2-ton, 2-whl, M106	7.93	12.28	14.78	7	10	11
Trailer, basic utility, pole type, 2 1/2-ton, 2-whl	7.99	13.17	15.67	7	10	12
Semitrailer, van, cargo, 6-ton, 2-whl, M118, with dolly converter, 2-whl, 6-ton, M197.	11.84	20.51	25.12	10	17	20
Truck, cargo, 5-ton, 6x6, M41.						
Trailer, cargo, 1 1/2-ton, M104	11.12	17.79	21.54	10	15	18
Compressor, air, tlr-mtd, 4-whl, DED, 315CFM	16.80	21.97	24.47	--	--	--
Dryer, aggregate, 80-150 TPH, tlr-mtd, Barber Greene Model 833.	31.62	----	39.29	24	--	30
Trailer, ammunition, 8-ton, 4-whl, M23, w/limber, carriage M5.	15.86	29.03	31.53	11	22	25
Mixer, bituminous material, 110-200 TPH, tlr-mtd, Barber Greene Model 848.	23.42	----	35.19	19	--	30
Truck, cargo, 5-ton, 6x6, M54.						
Dryer, aggregate, 80-150 TPH, tlr-mtd, Barber Greene Model 833.	31.67	--	41.84	24	--	32
Howitzer, heavy, towed, 8-inch, M115	24.97	----	35.14	20	--	29
Mixer, bituminous material, 110-200 TPH, tlr-mtd, Barber Greene Model 848.	23.47	----	27.74	19	--	32
Semitrailer, tank, gasoline, 5000-gal., 4-whl, M131A1 w/trl converter M198A1.	18.83	33.82	44.31	16	27	37
Trailer, cargo, 1 1/2-ton, 2-whl, M104	11.17	17.84	24.09	9	15	20
Trailer, low-bed, 8-ton, Fruehauf Model CPT-8	14.47	----	32.64	--	--	--
Truck, cargo, 5-ton 6x6, M55.						
Howitzer, heavy, towed, 8-inch, M115	27.03	32.03	37.03	21	25	30
Trailer, ammunition, 8-ton, 4-whl, M23, w/limber, carriage M5.	17.97	----	35.97	--	--	--
Truck, cargo, 10-ton, 6x6, M125.						
Mixer, bituminous material, 110-200 TPH, tlr-mtd, Barber Greene Model 848.	29.12	----	48.22	23	--	41
Howitzer, heavy, towed, 8-inch, M115	30.60	40.40	46.60	24	32	36
Trailer, ammunition, 8-ton, 4-whl, M23, w/limber, carriage M5.	21.74	----	44.74	17	--	37
Truck, dump, 5-ton, 6x6, M51.						
Bin, aggregate loading, tlr-mtd, 30-ton, Universal Model PB-20.	17.19	----	17.19	12	--	12
Mixer, bituminous material, 110-200 TPH, tlr-mtd, Barber Greene Model 848.	24.83	----	39.11	20	--	33
Trailer, basic utility, pole type, 2 1/2-ton, 2-whl	12.53	20.21	25.21	10	17	21
Truck, tractor, 2 1/2-ton, 6x6, M221.						
Semitrailer, van, cargo, 6-ton, 2-whl, M119 and M119A1 ...	9.82	15.82	17.92	8	14	16

Vehicle description	Weight (short tons)			Class		
	Loaded			Loaded		
	E	C	H	E	C	H
Truck, tractor, 2 1/2-ton, 6x6, M275.						
Semitrailer, stake and platform, 5-ton, 2-whl, Olsen Model 516	9.12	14.12	16.62	8	12	15
Truck, tractor, 5-ton, 6x6, M52.						
Codling tower, semitrailer-mtd, 4-sec., 2400 GPM	----	17.3	17.3	--	13	13
Semitrailer, tank, gasoline, 12-ton, 4-whl, 5000-gal., M131	16.93	26.74	32.20	13	22	28
Semitrailer, tank, gasoline, 12-ton, 4-whl, 5000-gal., M131C	16.58	27.77	33.86	13	24	30
Semitrailer, van, cargo, 12-ton, 4-whl, M127	16.25	28.25	34.25	12	25	31
Semitrailer, low-bed, 15-ton, 4-whl, M172	16.78	----	31.78	12	--	25
Semitrailer, low-bed, 25-ton, 4-whl, M172A1	16.78	----	41.78	12	--	35
Semitrailer, low-bed, wrecker, 12-ton, 4-whl, M270	18.25	30.25	38.25	13	23	30
Semitrailer, tank, alcohol, 3000-gal., 2-whl, M338	13.21	21.19	21.19	10	18	18
Semitrailer, stake, 12-ton, 4-whl, M127A1	15.68	27.78	33.78	12	23	29
Semitrailer, mobile, sawmill, Sawmobile Model 58	----	28.87	28.87	--	22	22
Truck, tractor, 10-ton, 6x6, M123.						
Semitrailer, tank transporter, 50-ton, 8-whl, M15A2	33.20	----	89.83	21	--	72
Semitrailer, tank transporter, 45-ton, 8-whl, M15A1	35.66	----	80.66	24	--	65
Semitrailer, tank transporter, 45-ton, 8-whl, M15	35.66	----	75.66	24	--	60
Semitrailer, tank, gasoline, 12-ton, 4-whl, 5000-gal., M131	21.90	31.71	37.17	17	26	31
Semitrailer, low-bed, wrecker, 12-ton, 4-whl, M269	21.57	33.57	41.57	16	26	33
Semitrailer, low-bed, 25-ton, 4-whl, M172A1	22.63	47.63	52.63	17	37	42
Truck, tractor, 12-ton, 6x6, M26.						
Trailer, low-bed, 60-ton, Rogers Model D-60-DS	41.45	----	101.45	30	--	108
Semitrailer, tank transporter, 45-ton, 8-whl, M15A1	45.64	----	90.64	32	--	73
Semitrailer, tank transporter, 40-ton, 8-whl, M15	45.64	----	85.64	32	--	68
Semitrailer, tank, gasoline, 12-ton, 4-whl, 5000-gal., M131	31.88	41.69	47.15	25	33	37
Truck, tractor, wrecker, 5-ton, 6x6, M246.						
Dryer, aggregate, 80-120 TPH, tlr-mtd, Barber Green Model 833.	----	----	43.66	--	--	35
Trailer, ammunition, 8-ton, 4-whl, M23, w/limber, carriage M5	22.35	----	38.53	18	--	32
Mixer, bituminous material, 110-200 TPH, tlr, mtd, Barber Greene Model 848.	29.91	----	42.19	24	--	35
Semitrailer, tank, gasoline, 12-ton, 4-whl, 5000-gal., M131	23.85	33.66	39.12	19	28	33
Semitrailer, low-bed, 12-ton, 4-whl, M270A1	25.17	37.17	37.17	19	28	28
Tractor, full-tracked, high-speed, 13-ton, M5.						
Howitzer, medium, towed, 155mm, M114	----	21.61	21.61	--	18	18
Gun, antiaircraft, artillery, towed, 90mm, M118	----	19.32	19.32	--	16	16
Tractor, full-tracked, high-speed, 18-ton, M4.						
Howitzer, heavy, towed, 8-inch, M115	----	30.50	30.50	--	25	25
Gun, antiaircraft, artillery, towed, 90mm, M2, mount 90mm, M2.	----	30.95	30.95	--	27	7

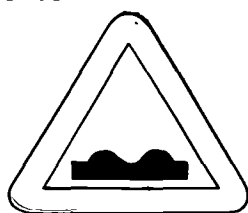
3-16. International (Geneva Convention) Road Signs

The road signs discussed in this paragraph were agreed upon at the United Nations Conference on Road and Motor Transport in 1949. Although these signs are not military, Army personnel should be familiar with them since they are used in oversea areas.

a. *Dimensions of Signs.* Dimensions of various signs are standardized in each country to insure maximum uniformity. In general, two

sizes are used for each type of sign—a standard size and a reduced size for use where conditions do not permit or the safety of road users does not require erection of the standard size. In exceptional circumstances, a small sign may be used inside built-up areas or for repetition of the main sign.

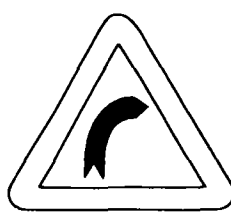
b. *Danger Signs (class I)* (fig. 3-10). Danger signs are in the shape of an equilateral triangle with one point upward, except in the case of the sign PRIORITY ROAD AHEAD



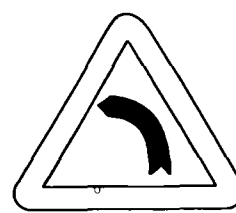
UNEVEN ROAD



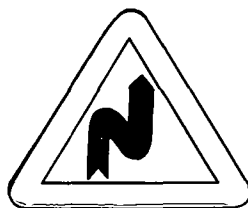
DANGEROUS BEND



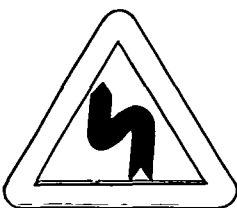
RIGHT BEND



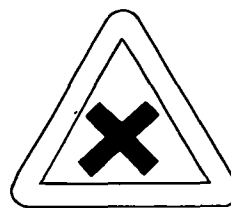
LEFT BEND



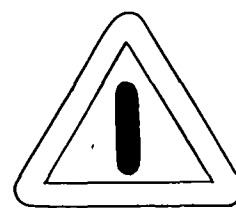
DOUBLE BEND
(FIRST TO THE RIGHT)



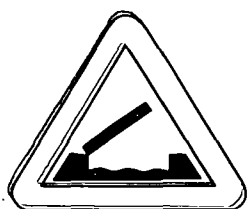
DOUBLE BEND
(FIRST TO THE LEFT)



ROAD INTERSECTION



OTHER DANGER



OPENING BRIDGE



ROAD REPAIR



SLIPPERY ROAD



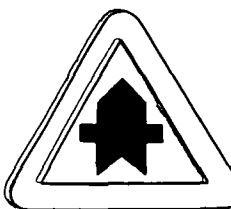
PEDESTRIAN
CROSSING



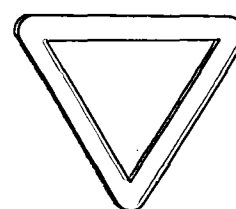
CHILDREN



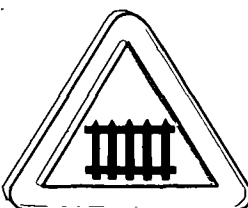
BEWARE OF
ANIMALS



INTERSECTION
WITH NONPRIORITY
ROAD



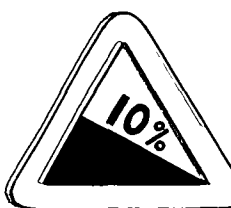
PRIORITY ROAD
AHEAD



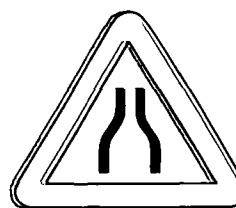
LEVEL R.R. CROSSING
WITH GATES



LEVEL CROSSING
WITHOUT GATES
(APPROACH SIGN)

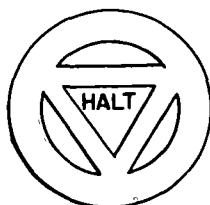
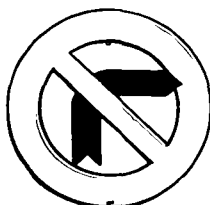


DANGEROUS HILL

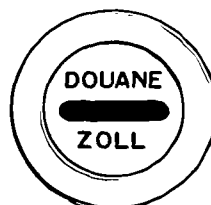


ROADWAY NARROWS

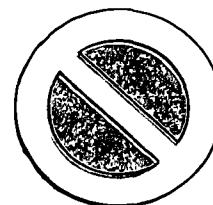
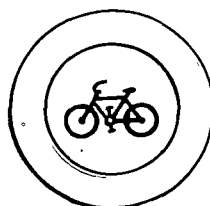
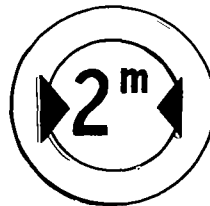
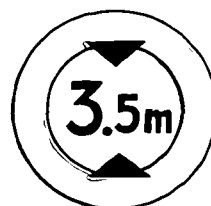
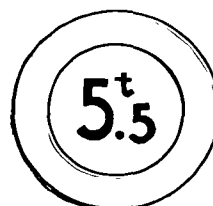
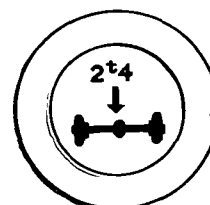
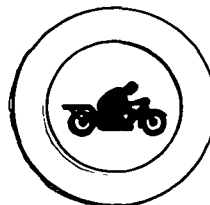
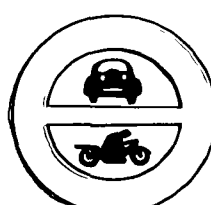
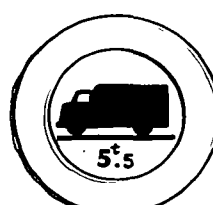
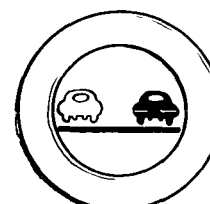
Figure 3-10. International road signs—danger.

STOP AT
INTERSECTION

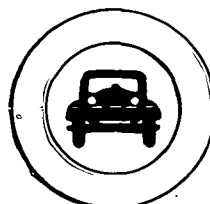
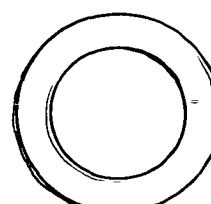
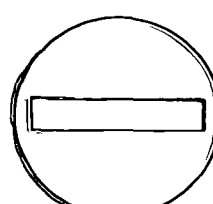
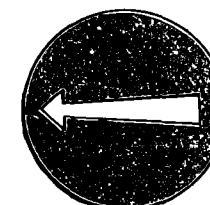
NO RIGHT TURN



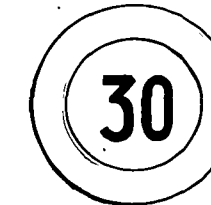
STOP--CUSTOMS

NO STOPPING
OR WAITINGBICYCLES
PROHIBITEDNO ENTRY FOR VEHICLES
HAVING OVERALL WIDTH
EXCEEDING _____ METERSNO ENTRY FOR VEHICLES
HAVING OVERALL HEIGHT
EXCEEDING _____ METERSNO ENTRY FOR VEHICLES
EXCEEDING _____ GROSS
WEIGHTNO ENTRY FOR VEHICLES
WITH AN AXLE WEIGHT
EXCEEDING _____ TONSNO ENTRY FOR
MOTORCYCLES
W/O SIDECARSNO ENTRY FOR
ALL MOTOR
VEHICLESNO ENTRY FOR GOODS-
CARRYING VEHICLES
EXCEEDING _____ TONS
LADEN WEIGHT

NO PASSING

NO ENTRY FOR ALL
VEHICLES EXCEPT
MOTORCYCLES W/O
SIDECARSCLOSED TO ALL
VEHICLESNO ENTRY FOR
ALL VEHICLES

TURN LEFT

COMPULSORY CYCLE
TRACK

SPEED LIMIT



NO PARKING

Figure 3-11. International road signs—definite instructions.

which has one point downward. These signs have red borders with white or yellow backgrounds. Symbols are black or some other dark color. For signs of standard size, the length of each side of the triangle is not less than 2 feet 11.4 inches (0.90 m), and, for the reduced size, not less than 1 foot 11.6 inches (0.60 m). Signs are not more than 7 feet 2.6 inches (2.20 m) above the ground at the highest point. Away from built-up areas, they are not less than 1 foot 11.6 inches (0.60 m) above the ground at the lowest point. Signs are so placed that they are clearly visible but do not impede pedestrians.

c. Signs Giving Definite Instructions (class II). The signs of this class indicate an order, which may be in the nature of either a prohibition or an obligation (fig. 3-11). They are circular with a diameter of at least 1 foot 11.6 inches (0.60 m) for signs of standard size, and at least 1 foot 3.7 inches (0.40 m) for signs of reduced size. They are placed in the immediate vicinity of the point where the prohibition or obligation begins and at intervals along the route. They are not more than 7 feet 2.6 inches (2.20 m) above the ground at the highest point, and not less than 1 foot 11.6 inches (0.60 m) above the ground at the lowest point.

(1) *Prohibitory signs (class II A).* These signs are white or light yellow with red borders, and the symbols are black or some other dark color. Examples of signs in this category are—

(a) Prohibitions for all traffic.

(b) Prohibitions for certain classes of vehicles.

(c) Restrictions on the dimensions, weight, or speed of vehicles.

(2) *Mandatory signs (class II B).* These signs are blue with white symbols. Examples of mandatory signs are—

(a) A direction to be followed.

(b) Where cyclists must ride.

d. Informative Signs (class III) (fig. 3-12). Signs of this class are rectangular. Where the colors are not specifically prescribed, red does not dominate.

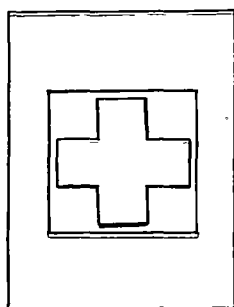
(1) *Indication signs (class III A).* Signs of this type are used to indicate parking areas, hospitals, first aid stations, telephones, filling stations, and priority roads. These signs have blue backgrounds, except those indicating priority roads. Signs indicating priority roads are diamond shaped and are white with black or dark rims on the outside and have yellow centers. Priority road signs are square with one point downward. The side of the square is at least 1 foot 11.6 inches (0.60 m) for the standard size, and at least 1 foot 3.7 inches (0.40 m) for the reduced size. For signs repeated within built-up areas, the side of the square is 9.8 inches (0.25 m).

(2) *Advance direction signs and direction signs (class III B).* The size of these signs is such that the indication can be understood easily by drivers in time to enable them to comply. They have either light backgrounds with dark lettering or dark backgrounds with light lettering. Advance direction signs are placed at a distance of between 328 feet (100 m) and 820 feet (250 m) from the intersection on normal roads. On special roads, e.g., concrete multilane roads, this distance is increased to 1,640 feet (500 m). Direction signs are rectangular with the longer side horizontal and end in an arrowhead. Names of places lying in the same direction may be added to the sign. Colors of these signs are the same as for advance direction signs. When distances are indicated, the figures giving distances are inscribed between the name of the place and the arrowhead.

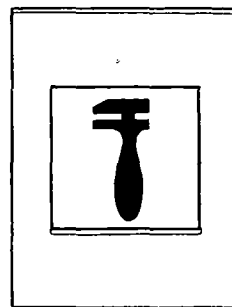
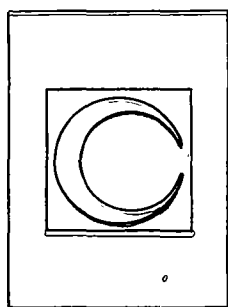
(3) *Place identification signs (class III C).* Signs indicating a locality are rectangular with the longer side horizontal. They are of such size and location that they are visible at night. They have either light backgrounds with dark lettering, or dark backgrounds with light lettering. They are placed before the beginning of a built-up area, and at other points necessary to indicate place locations.

3-17. NATO Military Road Signs

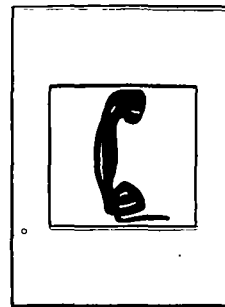
To facilitate the movement of armed forces of the North Atlantic Treaty Organization (NATO) in any territory controlled by opera-



FIRST-AID STATION



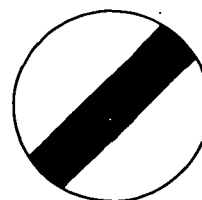
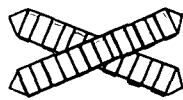
MECHANICAL HELP



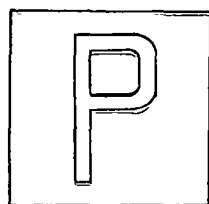
TELEPHONE



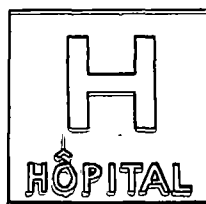
LEVEL R.R. CROSSING WITHOUT
GATES IN IMMEDIATE VICINITY



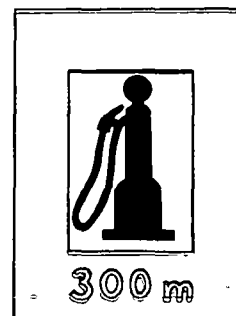
END OF SPEED LIMIT



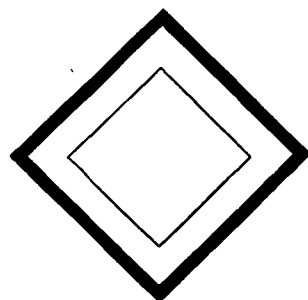
PARKING
PERMITTED



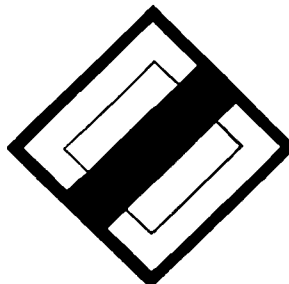
HOSPITAL



FILLING STATION

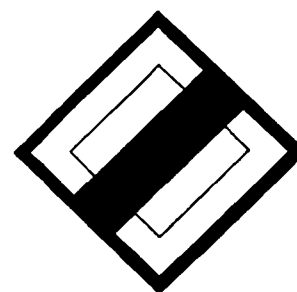


PRIORITY ROAD



200m

APPROACH TO END OF
PRIORITY ROAD



END OF PRIORITY ROAD

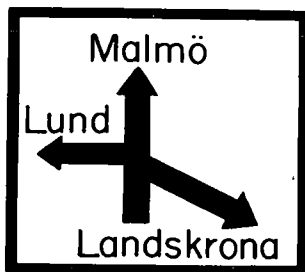
Figure 3-12. International road signs—informative.



DISTANCE SIGNS

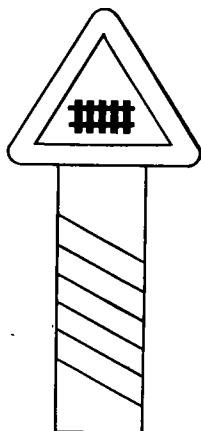


LOCALITY SIGNS

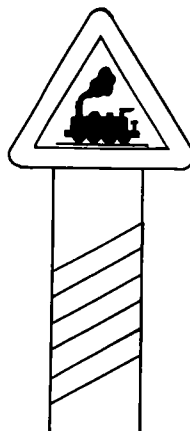


DIRECTION SIGNS

MILESTONE



A



B



C



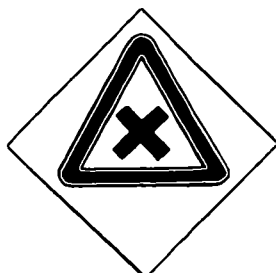
D

SUPPLEMENTARY RAILWAY SIGNS

IF SIGN A OR SIGN B IS DISPLAYED, IT MUST BE FOLLOWED BY SIGN C AND THEN SIGN D, INDICATING 2/3 AND 1/3 OF THE DISTANCE TO THE DESIGNATED POINT DESCRIBED IN THE ORIGINAL SIGN.

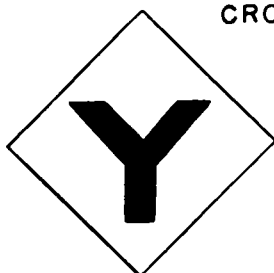
Figure 3-12—Continued.

HAZARD

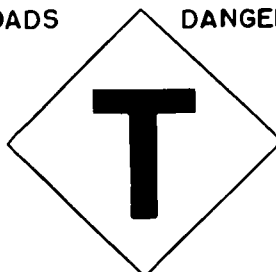


CROSSROADS

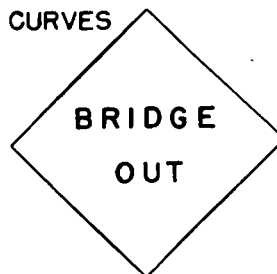
DANGEROUS CURVES



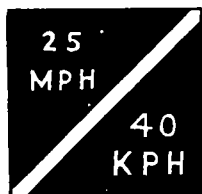
Y-JUNCTION



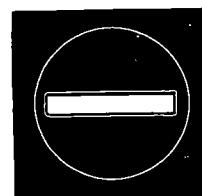
T-JUNCTION



REGULATORY



SPEED LIMIT



NO ENTRY

DETOUR



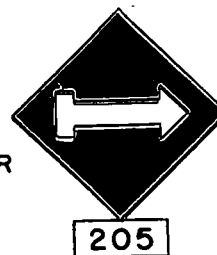
OR



DETOUR TO AXIAL
ROUTE 205 TO FRONT,
TURN RIGHT



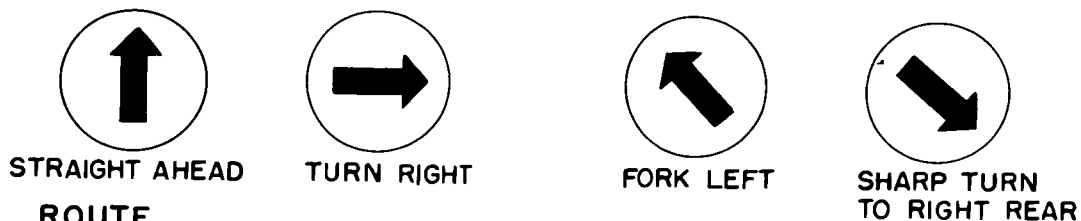
OR



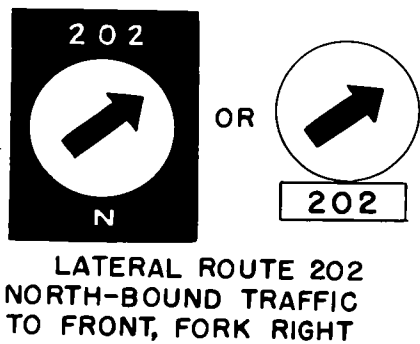
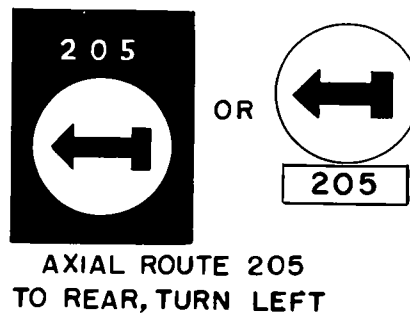
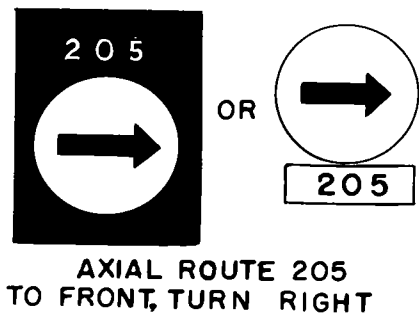
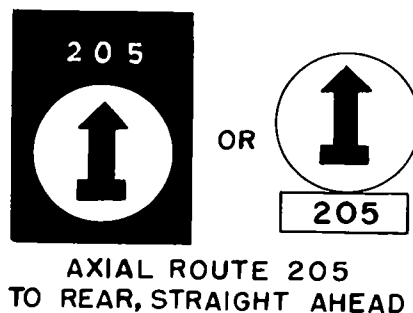
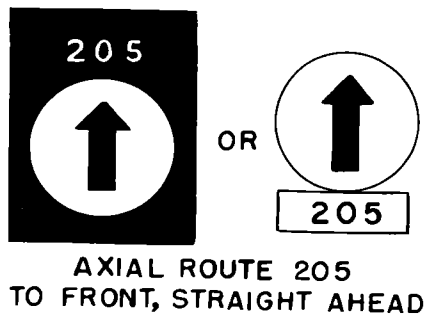
DETOUR TO AXIAL
ROUTE 205 TO REAR,
TURN RIGHT

Figure 3-13. NATO military road signs.

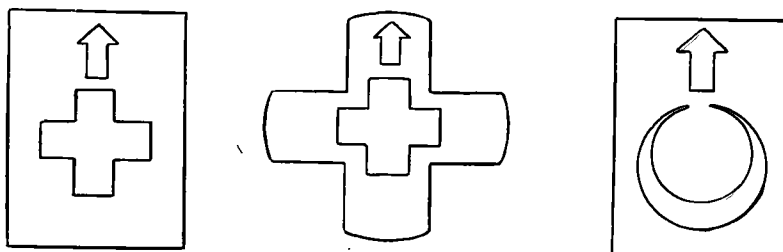
DIRECTIONAL DISK



ROUTE



CASUALTY EVACUATION ROUTE



(ALL MEDICAL UNITS EXCEPT TURKISH) (TURKISH MEDICAL UNITS)

Figure 3-13—Continued

tional military command or a national authority, a standard system of military route signs has been adopted by member governments. This system includes signs which the Geneva Convention already prescribes (para 3-16) and others not included in the Geneva Convention. Standard signs include hazard signs, regulatory signs, and guide signs. Examples are shown in figure 3-13.

a. Hazard Sign. This sign indicates a traffic hazard and is used only in areas under military authority. A hazard sign is square and is placed with one corner pointing downward. A purely military sign not included in the International (Geneva Convention) System or host country's system has a yellow background with the legend or symbol in black. If the sign is included in the International System or host country's system, the International or host country's sign is used to the same yellow background instead of the black symbol or legend.

b. Regulatory Sign. This sign is used to regulate and control traffic and to define the light line. A regulatory sign is square. It has a black background on which the legend is superimposed in white with the following exceptions: bridge classification signs, stop signs, no entry signs, blackout signs, and signs erected by the military for the control of civilians under specified conditions. Descriptions of the accepted regulatory signs are contained in STANAG No. 2010 and STANAG No. 2012 (Edition No. 2).

c. Guide Sign. A guide sign is used to indicate locations, distances, directions, routes, and similar information.

(1) A guide sign for a route is rectangular with the long axis vertical. The legend or symbol and route number are superimposed in white on a black background. Odd numbers are used for axial routes, and even numbers designate lateral routes.

(2) A directional disk is used as a supplement to other guide signs to indicate the direction of a route or as an appendage to any major-unit sign to indicate the route to that unit. The disk is less than 16 inches (0.41 m) in diameter and has a black arrow, with or

without bar, on a white background. Eight equally spaced holes around its circumference allow the disk to be nailed with the arrow pointing in any direction. Battalions and lower units are not permitted to install directional disks.

(3) A guide sign for a casualty evacuation route is either rectangular or cross-shaped with symbols in red on a white background.

(4) A detour sign has a white arrow, barred or not, on a blue square. The sign is placed so that one corner of the square points downward.

3-18. Marking of Contaminated or Dangerous Land Areas

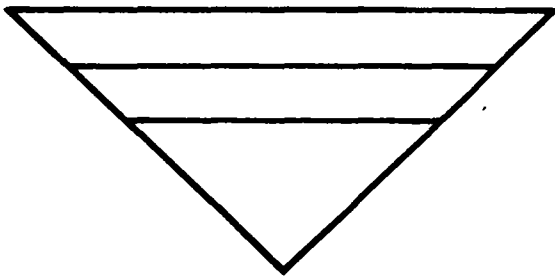
Roads and areas within NATO nations containing radiological, biological, or chemical contamination; minefields; boobytraps; or unexploded bombs will be marked by triangular signs in accordance with the details of the agreement of STANAG No. 2002. Examples are shown in figure 3-14.

3-19. NATO Markings for Military Vehicles

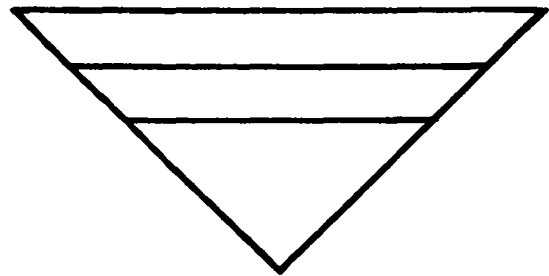
a. General. The armed forces of NATO have agreed to use the standard markings for vehicles described below. (SEATO Military Vehicle Markings are prescribed by CSTAG 20-27.) The markings listed are not necessarily used at all times, but when they are used, vehicles are marked in accordance with the following paragraphs. The rear of a trailer is marked in the same way as its prime mover; there is no need to mark the front of a trailer. When necessary for security reasons, vehicle marking may, by direction of the field commander or his superior authority, be covered or removed.

b. Registration Numbers. The marking of vehicles for registration is as required by the nation concerned. Registration markings consist of numbers or a combination of letters and numbers.

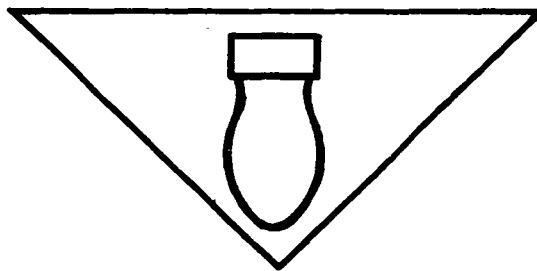
c. National Symbols. National symbols are used to identify the vehicles of each country. At a minimum, symbols are shown front and rear. Service symbols may be superimposed up-



**CHEMICAL
MINEFIELDS**



BOOBY TRAPS



UNEXPLODED BOMB

Figure 3-14. Markings of contaminated or dangerous land areas (STANAG No. 2002).

on the national distinguishing symbols or shown separately by an additional symbol.

d. Speed Limits. Speed limit markings are placed on vehicles as directed by the nation concerned.

e. Tactical Markings. Tactical markings serve in general as identification markings within units; they consist of stripes and geometrical figures or combinations thereof and may also include a name. Colors may be used. Markings should be large enough to make ground-to-ground identification of vehicles possible; they are used primarily for easy battlefield recognition. The design and position of these markings are prescribed by the field commander directing their use. They are removed when vehicles are permanently released from the jurisdiction of the commander who prescribed their use.

f. Ground-to-Air Recognition. Equipment for these markings consists of red and yellow fluorescent panels equipped with tie cords. Panel dimensions are approximately 6 feet by 2 feet 3 inches (1.80 m by 0.68 m). Panels are draped on vehicles in a standard, unchanging pattern that differs from the displays prescribed for other recognition purposes (frontlines, targets, etc.). Theater commanders prescribe the arrangement of panels and the conditions under which they will be used.

g. Special. Military police vehicles and other traffic control vehicles are identified, front and rear, with the prescribed markings. Ambulances and other vehicles used exclusively for medical purposes are marked according to the rules of the Geneva Convention. Such markings consist of one red cross or crescent

on a square white background painted on the side body panels, roof of body, roof of driver's cab, and rear door(s) or panel.

h. Bomb Disposal Units. Vehicles of bomb disposal units have all fenders painted red.

i. Danger. A red flag flown from any vehicle indicates DANGER.

j. Priority Vehicles. Any vehicle which for any reason (special liaison officer, signal vehicles carrying priority dispatches, damage assessment personnel, etc.) requires priority over all other vehicles may be so marked by any commander having area responsibility. Such priority markings are valid only in the area of the commander concerned. The markings consist of equilateral triangles with red borders and symbols on white backgrounds on the front and rear of the vehicle (fig. 3-15). A single priority sign may be used if visible from both front and rear. The size of a priority sign should be as large as the dimensions of the vehicle permit. The symbol inside the triangle indicates the commander authorizing use of this priority sign. This sign must be removable in order to avoid misuse and is used only on direct orders of the commander concerned.

k. Organization of Columns.

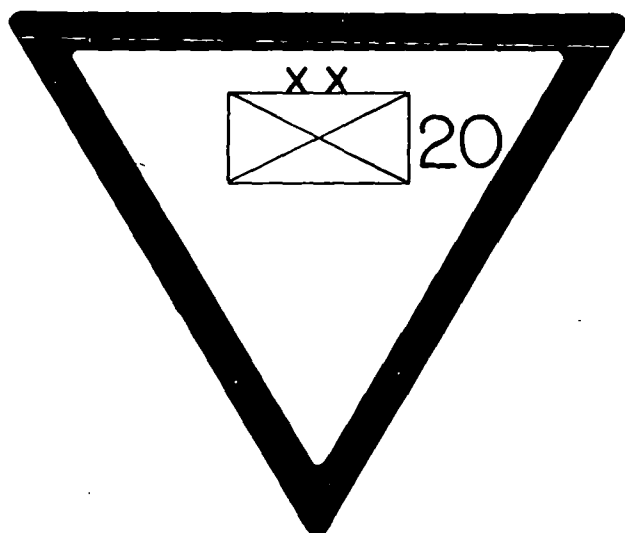


Figure 3-15. Vehicle priority sign.

(1) A column of vehicles is a group of at least 10 vehicles moving under a single commander, over the same route, in the same direction.

(2) To facilitate control, large columns may be broken down to serials and march units.

(3) Each column and each organized element must include the following:

(a) A commander, whose place in the column may vary. The pace setter of the first element of a column leads it and regulates its speed.

(b) In the first vehicle, a subordinate commander known as the pace setter.

(c) In the last vehicle, a subordinate commander known as the trail officer. The trail officer of the last element deals with such problems as occur at the tail of the column.

l. Identification of Columns.

(1) Each column will be identified in accordance with STANAG No. 2027, i.e., blue flag on leading vehicle, green flag on last vehicle. In addition, when movement is being carried out at night, the leading vehicle will show a blue light and the last vehicle will show a green light. The vehicle of the column commander displays a flag that is bisected by a diagonal line to form two triangles. The upper triangle is white; the lower is black. In areas where vehicles drive on the left side of the highway, the flags are mounted on the right side of the vehicle; otherwise, they are mounted on the left side.

(2) Each column will be identified by a number known as "movement number" or "identification serial number" which is allocated at the same time as the "movement credit" by the authority organizing the movement (*m* below). This number will identify the column during the whole of the movement.

(3) The number will be placed on both sides and, if possible, on the front of all vehicles composing the column so as to be clearly visible. It will be composed of the following:

(a) Two figures indicating the day of

the month on which the movement is due to commence.

(b) Three or four letters indicating the authority organizing the movement. The first two letters will be the national symbols shown in STANAG No. 1059 (Edition No. 2).

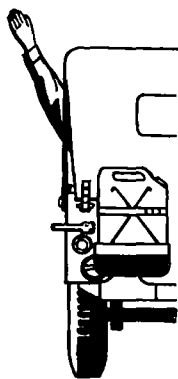
(c) Two figures indicating the serial number allocated by the authority responsible for the movement. For example, 03-USV-08 will indicate that column No. 8, composed of V

corps vehicles, will be moved by United States authority on the third day of the current month.

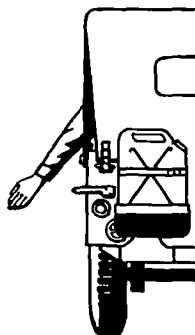
(d) The elements of a column may be identified by adding a letter behind the movement number.

m. Movement Credit.

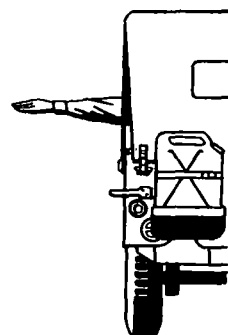
(1) A movement credit is the time allocated to one or more vehicles to move over a supervised, dispatch, or reserved route.



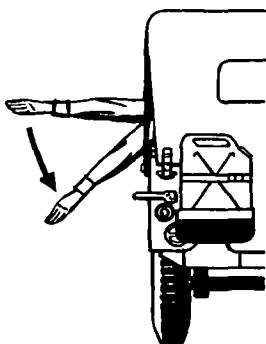
① RIGHT TURN



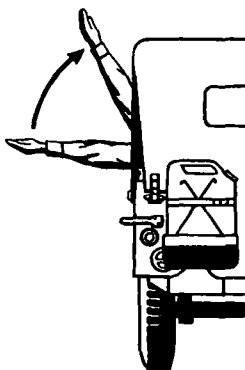
② STOP



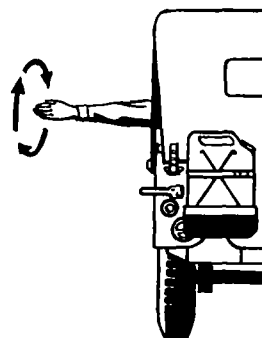
③ LEFT TURN



④ OPEN UP



⑤ CLOSE UP



⑥ PASS AND KEEP GOING

Figure 3-16. Driver arm and hand signals.

(2) Besides the allocation of a movement number or identification serial number, a movement credit includes the indication of times at which the first and last vehicle of a column are scheduled to pass—

(a) The entry point—where the column enters the controlled route.

(b) The exit point—where the column leaves the controlled route.

3-20. Arm and Hand Signals

a. The safe operation of motor vehicles often depends upon the driver's knowing and using the arm and hand signals shown in figure 3-16.

b. The current concept of tactical operations requires that vehicle drivers be trained to operate their vehicles under blackout conditions and to recognize operational night hand signals (fig. 3-17). These signals provide a means of control at night or when radio silence and security requirements are at a maximum.

c. The arm and hand signals illustrated in figure 3-18 are the common means for transmitting visual messages within administrative and tactical units of the armed forces. They must be memorized and practiced until they become second nature. Visual signals are useless if not correctly and distinctly interpreted. The signals illustrated with a single-headed arrow indicate the signal is a single action which may be repeated until acknowledged or executed. Signals illustrated with a double-headed arrow are continuous until acknowledged or executed. For additional information see FM 21-60.

3-21. Basic March Formulas¹

a. *General.* There are three basic march factors: distance (*D*), rate (*R*), and time (*T*). When two are known, the third can be found by using the formula shown below. Corresponding units of measure must be used throughout.

$$R = \frac{D}{T} \quad T = \frac{D}{R} \quad D = RT$$

b. *Rate Factors.*

$$\text{Rate (yards per minute)} = \frac{\text{length (yards)}}{\text{past time (minutes)}}$$

¹ For time and space definitions, see FM 55-35.

$$\text{Rate (meters per minute)} = \frac{\text{length (meters)}}{\text{pass time (minutes)}}$$

$$\text{Rate (miles in the hour (mih))} = \frac{\text{road distance (miles)}}{\text{time distance (hours)}}$$

$$\text{Rate (kilometers in the hour (kmih))} = \frac{\text{road distance (kilometers)}}{\text{time distance (hours)}}$$

c. Time Factors.

$$\text{Pass time (minutes)} = \frac{\text{length (yards)}}{\text{rate (yards per minute)}} = \frac{\text{length (meters)}}{\text{rate (meters per minute)}}$$

$$\text{Time lead (minutes)} = \frac{\text{lead (yards)}}{\text{rate (yards per minute)}} = \frac{\text{lead (meters)}}{\text{rate (meters per minute)}}$$

$$\text{Time gap (minutes)} = \frac{\text{gap (yards)}}{\text{rate (yards per minute)}} = \frac{\text{gap (meters)}}{\text{rate (meters per minute)}}$$

$$\text{Time space (hours)} = \frac{\text{road space (miles)}}{\text{rate (mih)}} = \frac{\text{road space (kilometers)}}{\text{rate (kmih)}}$$

$$\text{Pass time (hours)} = \frac{\text{road distance (miles)}}{\text{rate (mih)}} = \frac{\text{road distance (kilometers)}}{\text{rate (kmih)}}$$

d. Distance Factors.

$$\text{Length (yards)} = \text{rate (yards per minute)} \times \text{pass time (minutes)}$$

$$\text{Length (meters)} = \text{rate (meters per minute)} \times \text{pass time (minutes)}$$

$$\text{Lead (yards)} = \text{rate (yards per minute)} \times \text{time lead (minutes)}$$

$$\text{Lead (meters)} = \text{rate (meters per minute)} \times \text{time lead (minutes)}$$

$$\text{Gap (yards)} = \text{rate (yards per minute)} \times \text{time gap (minutes)}$$

$$\text{Gap (meters)} = \text{rate (meters per minute)} \times \text{time gap (minutes)}$$

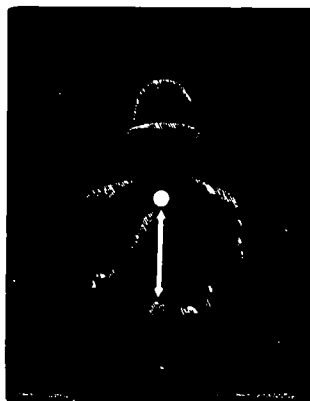
$$\text{Road space (miles)} = \text{rate (mih)} \times \text{time space (hours)}$$

$$\text{Road space (kilometers)} = \text{rate (kmih)} \times \text{time space (hours)}$$

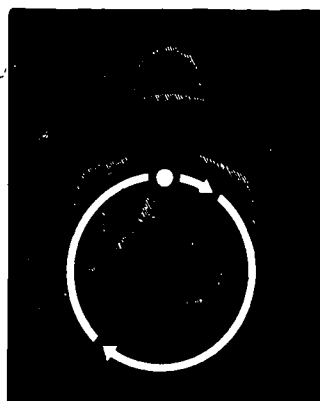
$$\text{Road distance (miles)} = \text{rate (mih)} \times \text{time distance (hours)}$$

$$\text{Road distance (kilometers)} = \text{rate (kmih)} \times \text{time distance (hours)}$$

e. *Time-Distance Factors* (fig. 3-19). When the speed in miles or kilometers per hour is known, the time in minutes or the distance in miles or kilometers traveled can be quickly determined from a time-distance graph (fig.



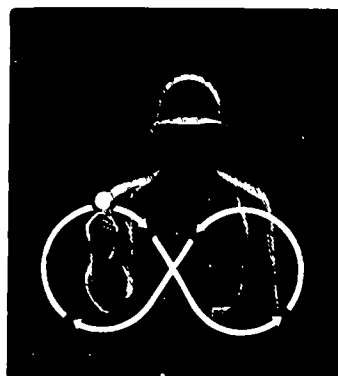
- ① Go; or Forward; or Move out; or Increase speed; or Double time.
The light is moved several times vertically in front of the body.



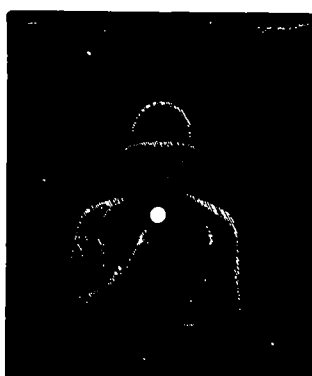
- ② Turn right. The light is rotated in the direction of the turn.



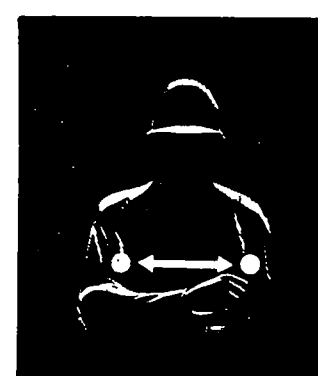
- ③ Turn left. The light is rotated in the direction of the turn.



- ④ Start engine(s). The light is so moved as to describe the figure 8 (on its side) in a vertical plane in front of the body of the individual giving the signal.



- ⑤ Move in reverse. The light is held at shoulder level and blinked several times toward the vehicle.



- ⑥ Stop; or Stop engine(s). The light is moved horizontally back and forth several times across the path of approaching traffic to stop traffic. The same signal is used to stop engines.

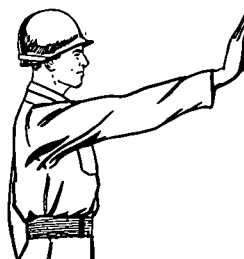
Figure 3-17. Night hand signals.



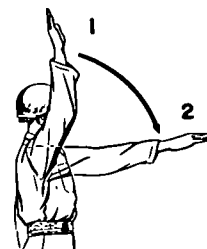
A. ATTENTION



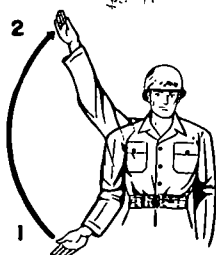
B. ASSEMBLE



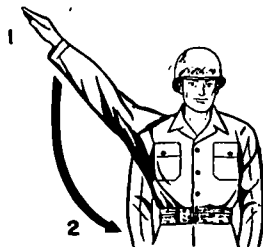
C. READY



D. FORWARD, OR TO THE REAR (Vehicles or individuals turn simultaneously)



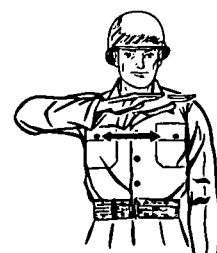
E. MOUNT



F. DISMOUNT



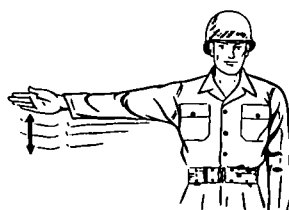
G. START ENGINE(S), OR PREPARE TO MOVE



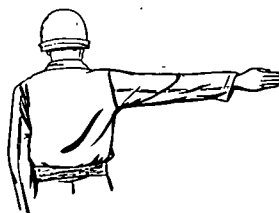
H. STOP ENGINE(S)



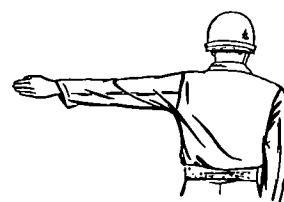
I. INCREASE SPEED, OR DOUBLE TIME, OR RUSH



J. DECREASE SPEED (Vehicles)



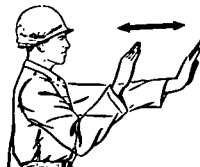
K. RIGHT TURN; OR COLUMN RIGHT



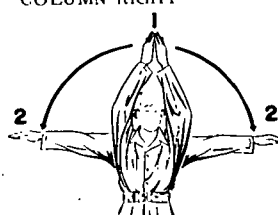
L. LEFT TURN; OR COLUMN LEFT



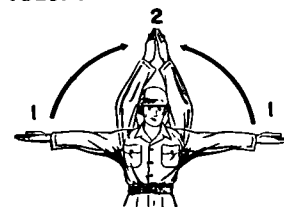
M. MOVE AHEAD, OR JOIN ME; OR FOLLOW ME



N. MOVE IN-REVERSE



O. EXTEND (From Turret, Ground, or Open Vehicle)



P. CLOSE UP (From Turret, Ground or Open Vehicle)



Q. HALT; OR STOP



R. CLOSE UP AND STOP



S. DISREGARD PREVIOUS COMMAND; OR AS YOU WERE



T. VEHICLE OUT OF ACTION

Figure 3-18. Motor march arm and hand signals.

3-20). For example, if a convoy moves at a speed of 15 miles per hour (24.14 kmph) for a 2-hour period, the distance traveled can be determined by—

(1) Locating the oblique line marked 15 mph (24.14 kmph).

(2) Locating the horizontal line, extending from the left margin, representing the 2 hours traveled.

(3) Determining the point at which these two lines intersect and reading the distance in miles or kilometers from scale along the bottom (miles) or top (kilometers) margin of the

graph. For this example, the distance traveled would be 30 miles (48.27 km).

f. Conversions.

(1) The following factors may be converted into distance, rate, or by arithmetic:

Length + gap = lead

Pass time (time length) + time gap = time lead

Distance (miles) $\times$ 1,760 = distance (yards)

Distance (kilometers) $\times$ 1,000 = distance (meters)

Time (hours) $\times$ 60 = time (minutes)

Rate (mih) $\times$ 30 = approximate yard per minute

Rate (kmih) $\times$ 17 = approximate meters per minute

(2) These factors are substituted in the

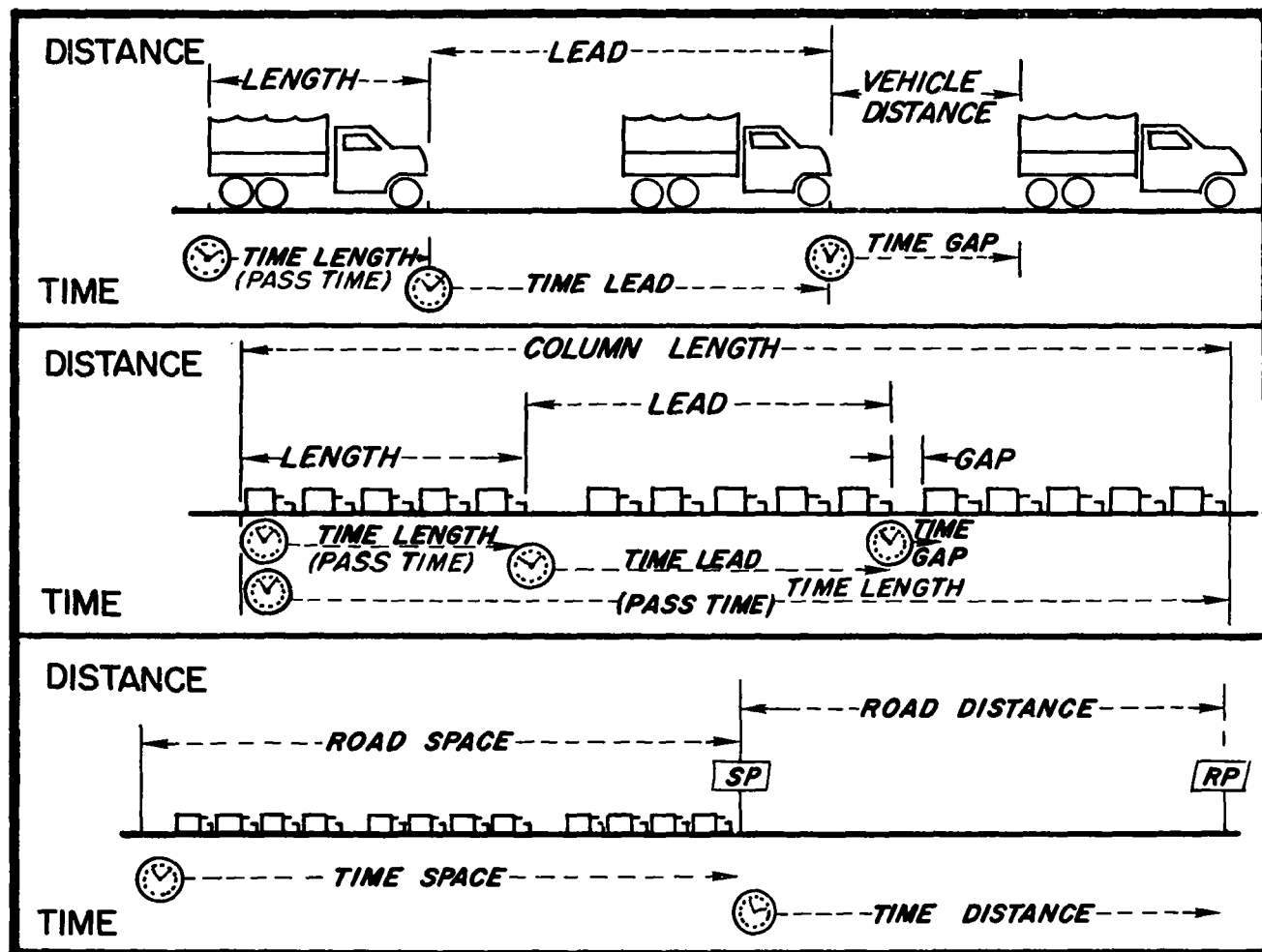


Figure 3-19. Space and time factors.

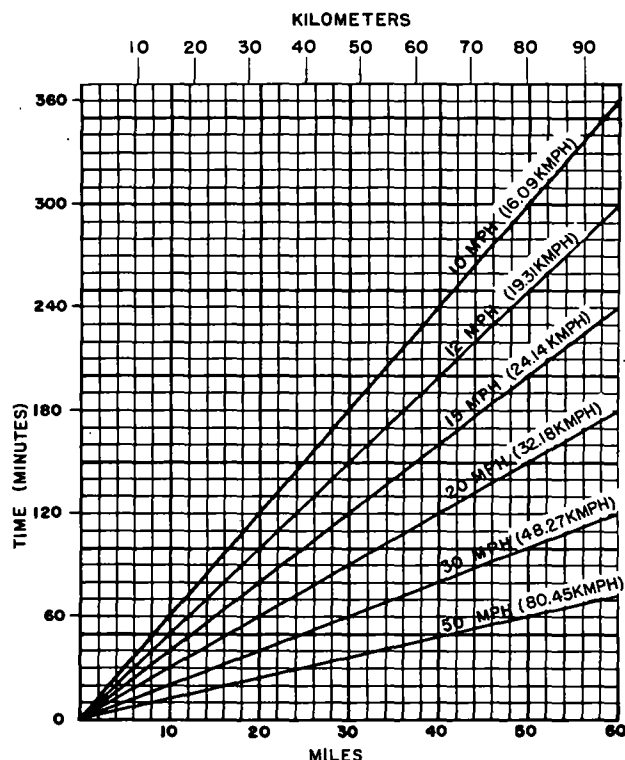


Figure 3-20. Time-distance graph.

basic formulas in *a* through *d* above.

For example.

$$\text{Pass time (minutes)} = \frac{\text{miles} \times 1,760}{\text{mih} \times 30} = \frac{\text{kilometers} \times 1,000}{\text{kmih} \times 17}$$

$$\text{Speed (yards per minute)} = \frac{\text{miles} \times 1,760}{\text{hours} \times 60}$$

$$\text{Speed (meters per minute)} = \frac{\text{kilometers} \times 1,000}{\text{hours} \times 60}$$

3-22. Basic Lengths

The length of any column or element of a column is the length of roadway which it occupies, measured from front to rear inclusive. For planning purposes, the average length of one motor transport vehicle is 10 yards (approximately 9 meters).

3-23. Road-Movement Graph

a. Definition. A road-movement graph (fig. 3-21) is a time-space diagram used in controlling both foot and road marches and in

preparing or checking road-movement tables. The graph helps the planner to foresee possible conflicts and discrepancies in planning.

b. Uses. Road-movement graphs may be used to indicate—

(1) Position of various mixed traffic on a route at a particular time.

(2) Scheduled passing of various elements of traffic at a particular point.

(3) Conflicts between various elements of traffic at junctions, intersections, bridges, and defiles.

(4) Deviations of columns from prescribed schedule.

(5) Reversing directions of march, either by simultaneous turn of all elements of a column or by circling about.

(6) Two-way traffic over a route and alternating traffic through defiles.

(7) Variations in actual running speeds and in the traffic flow and traffic density of a route.

c. Construction.

(1) Analyze the route on the map. Note important points, such as cities, towns, road junctions, bottlenecks, etc., to be passed through and the distance between major points along the route.

(2) Select graph paper with enough squares to plot distance and time involved. Across bottom left to right, place scale of time. In left margin, from bottom to top, place scale of distance.

(3) If the origin and destination, rate of march, and time of departure of a movement are known, schedule the head of the column as follows:

(a) Assume that a unit is to march from Mount Royal (25 miles (40.2 km) on the vertical scale), leaving a 0700 hours and proceeding at 15 miles in the hour (24.1 kmih) to a point 5 miles (7.4 km) beyond Tavistock. The distance is 60 miles (96.5 km). At 15 miles in the hour, it will require 4 hours to cover the 60 miles.

(b) Place a dot at the point where the

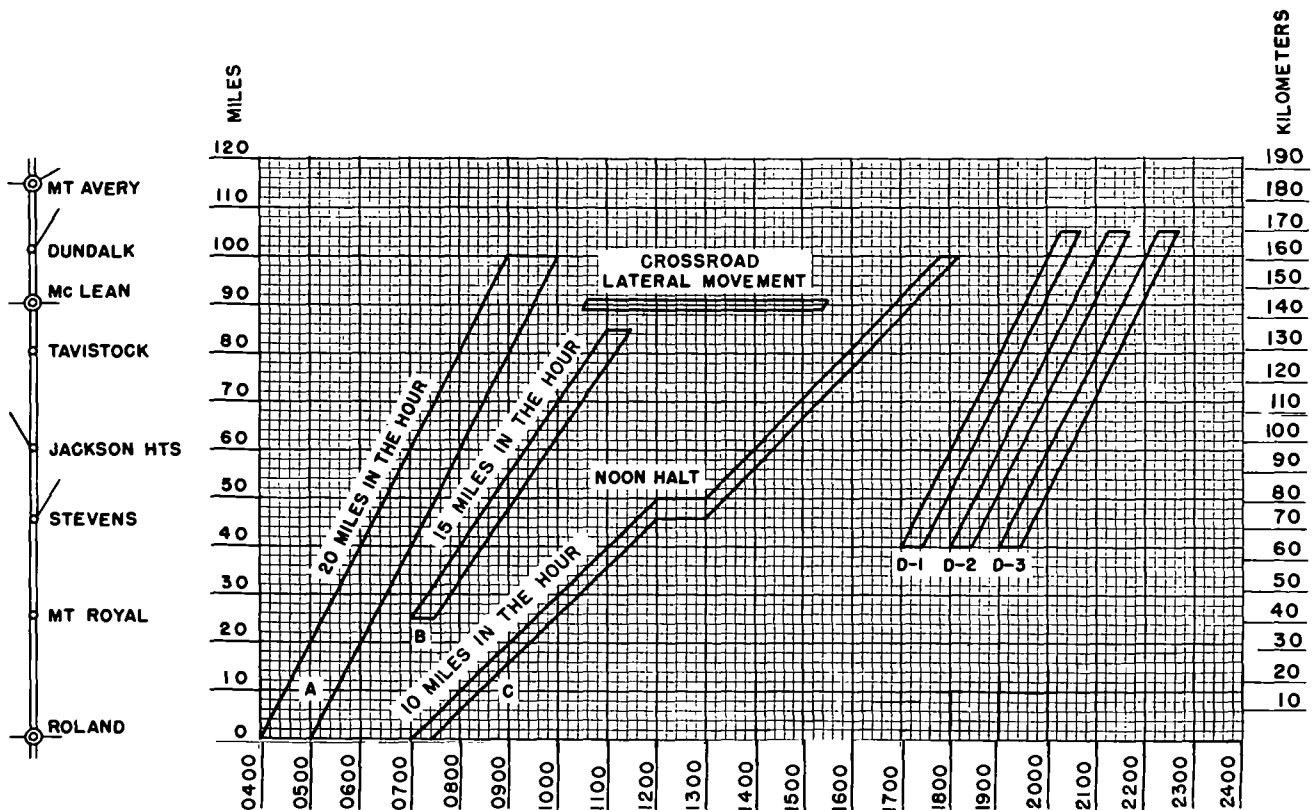


Figure 3-21. Road-movement graph.

line representing the place of departure (Mount Royal at 25 miles (40.2 km) on the vertical scale) intersects the line representing the hour of departure (0700 hours on horizontal scale).

(c) Place a second dot at the point where the line representing the destination (5 miles past Tavistock at the 85-mile (136.7 km) mark on the vertical scale) intersects that of hour of scheduled arrival of the head of the column at the destination (1100 hours on the horizontal scale or 0700 plus 4 hours).

(4) Unless the unit is very small, usually it is desirable to show the schedule of the tail of the column as well as the head. After charting the schedule of the head, schedule the tail of the time length of the column is known or can be computed. Assuming that the time length of the column, including extra time allowance, is 30 minutes, a line drawn from the point representing the clearance of the column

at origin (0730 hrs) and at the destination (1130 hrs) will be shown the schedule of the tail of the column past all points en route.

(5) To determine what time the column must start to complete the movement and arrive at the destination at a certain hour, reverse the above procedures.

d. Analysis. Length of column, pass time (time length), rate of march, and other factors may be determined from the road-movement graph as follows:

(1) *Length of column.* A vertical line connecting the head and tail lines, measured by the scale of miles or kilometers, will show the planned length of the column on the road at the prescribed rate of march at any hour during the movement, provided that the extra time allowance, if any, converted to distance is subtracted from the measurement.

Example: When the head of the column is at

Stevens (45 miles (72.4 km) on vertical scale), the tail will be at approximately the 38-mile (61.1-km) mark.

(2) *Pass time (time length)*. A horizontal line connecting the head and tail lines, measured by the scale of hours, will show the planned pass time of the column as it passes any point on the road.

Example: If the head of the column arrives at Tavistock at 1040 hours, the tail will not clear that point until half an hour later, at 1110 hours.

(3) *Rate of march*. The diagonal line of the graph indicates the rate of march.

Example: The distance (mile or kilometer scale) between the intersection of the diagonal line with any two vertical lines spanning a 1-hour period (time scale) indicates the distance in that hour.

e. Multiple Movements.

(1) A number of serials or columns over the same route can be scheduled by using a road-movement graph. The commander of a large unit or the highway regulation officer

can keep accurate records of the location of each serial by having information sent to him as each serial reaches or clears highway regulation points along the route of march. This information is indicated by filling in the space between the lines representing the scheduled head and tail of each column with color or tape. This enables the headquarters to see at a glance the location of each serial, to follow the progress of each movement, to correct situations which may cause congestion and delay, and to know where each serial can be reached in order to issue new orders if necessary.

(2) Colored pencils, crayons, ink, or adhesive tape may be used to indicate various schedules and the relative priority of movements or to plot movements in progress. For example, the head and tail schedule may be outlined by black lines, progress of each serial may be filled in with green, and failure to adhere to the schedule may be shown in red.

(3) Figure 3-22 shows the plotted progress of serials scheduled in figure 3-21. Note the changes and adjustments in schedules that had to be made. This is what happened—

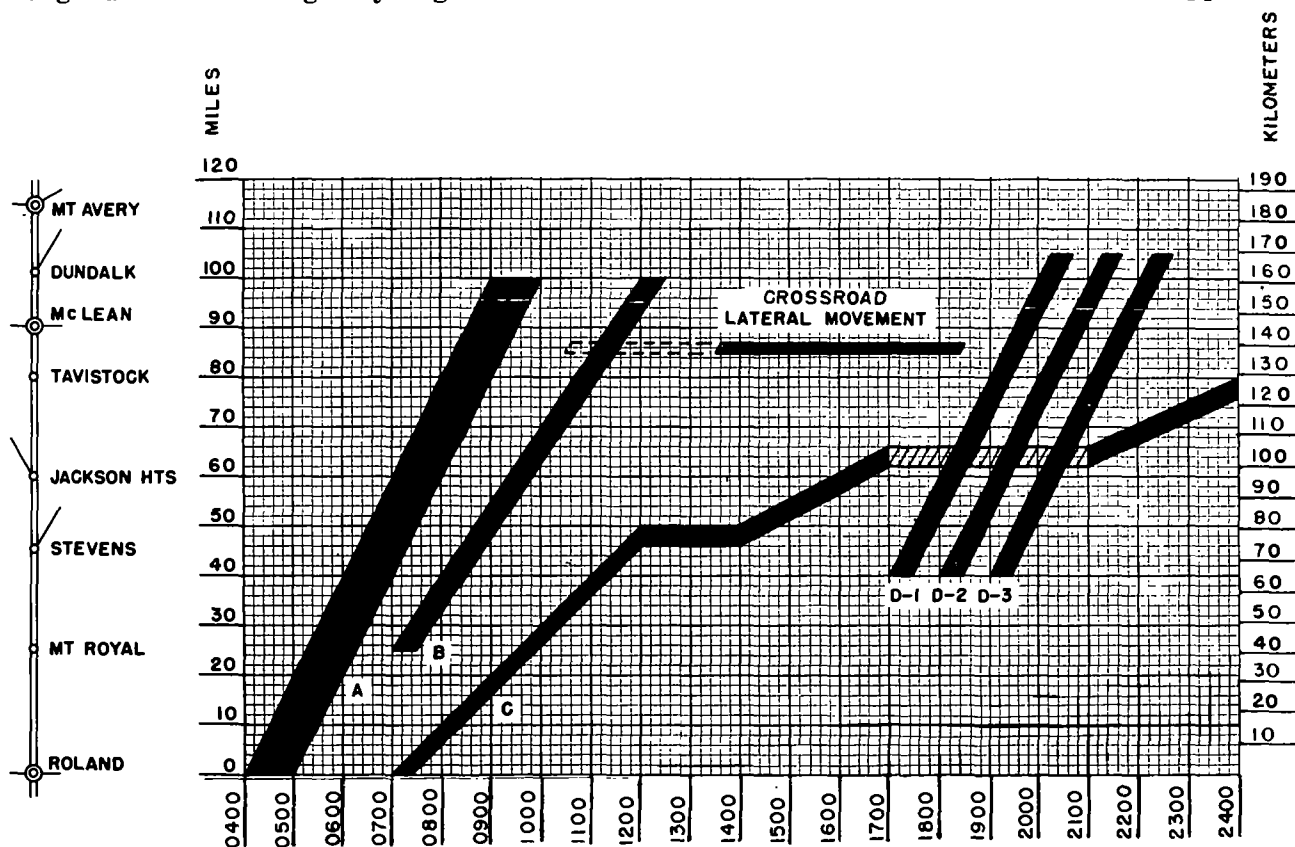


Figure 3-22. Deviations from schedules.

(a) *Serial A.* Went through as scheduled.

(b) *Serial B.* Change in orders required that serial B continue on to Dundalk. It continued on schedule, and the head of the column arrived at its new destination at noon.

(c) *Lateral movement.* Because of a change or orders for serial B, arrangements had to be made to hold the lateral movement at McLean. It made its noon halt and crossed the route 3 hours behind its original schedule, not clearing until 1830 hours.

(d) *Serial C.* At 1200 hours it became obvious that if serial C continued on schedule, it would conflict with the delayed lateral movement at about 1730 hours. Serial C also had lost priority, because of the arrival of serial B and Dundalk with critically needed supplies. Therefore, serial C was halted for 2 hours (from 1200 to 1400 hours). It continued at a slower rate of march until 1700 hours, when it was halted again to let serial D pass.

(e) *Serial D (D-1, D-2, D-3).* All elements went through on schedule.

3-24. Traffic Density

a. Traffic density is the average number of vehicles occupying a specified length of roadway at a given instant. Traffic density is expressed in vehicles per mile or kilometer and can be determined by the formulas shown below.

b. Any traffic density desired for dispersion or for maintaining the maximum capacity of a route may be arrived at by selecting an appropriate intervehicular gap and using the following formulas:

$$\frac{1 \text{ mile in yards}}{\text{Desired intervehicular gap in yards}} + \text{avg length of 1 veh} = \text{vehicles per mile}$$

$$\frac{1 \text{ kilometer in meters}}{\text{Desired intervehicular gap in meters}} + \text{avg length of 1 veh} = \text{vehicles per kilometer}$$

Example: If vehicles are dispersed every 100 yards (91.4 m), density is—

$$\frac{1,760}{100 + 10} = 16 \text{ vehicles per mile}$$

$$\frac{1,000}{91.4 + 9} = 10 \text{ vehicles per kilometer}$$

c. When the speed and speedometer multiplier are known, traffic density may be determined by using the following formulas:

$$\frac{1 \text{ mile in yards}}{(\text{Speed in mph} \times \text{speedometer multiplier})} + \text{avg length of 1 veh} = \text{vehicles per mile}$$

$$\frac{1 \text{ kilometer in meters}}{(\text{Speed in kmph} \times \text{speedometer multiplier})} + \text{avg length of 1 veh} = \text{vehicles per kilometer}$$

Example: If the speed of a column is 20 miles per hour (32.19 kilometers per hour) and speedometer multipliers of 2 for miles and 1.2 for kilometers are used, traffic density is—

$$\frac{1,760}{(20 \times 2) + 10} = 35 \text{ vehicles per mile}$$

$$\frac{1,000}{(32.19 \times 1.2) + 9} = 21 \text{ vehicles per kilometer}$$

d. At a constant speed, traffic density can also be determined by counting the number of vehicles passing a given point in a period of time. Use the following formulas:

$$\frac{\text{Vehicles per hour passing point}}{\text{Speed in miles per hour}} = \text{vehicles per mile}$$

$$\frac{\text{Vehicles per hour passing point}}{\text{Speed in kilometers per hour}} = \text{vehicles per kilometer}$$

Example: If 500 vehicles pass a given point in 1/2 hour at 20 miles per hour (32.19 kilometers per hour), traffic density is determined as follows:

$$500 \text{ vehicles per } \frac{1}{2} \text{ hour} = 1,000 \text{ vehicles per hour}$$

$$\frac{1,000}{20} = 50 \text{ vehicles per mile}$$

$$\frac{1,000}{32.19} = 31 \text{ vehicles per kilometer}$$

3-25. Road-Movement Table

a. A road-movement table provides a convenient means of transmitting to subordinates information about schedules and other essential details. This is particularly so if the inclusion of such details in the body of the operation order would tend to complicate it or make it unduly long. Tables frequently require a wider distribution than normal operation orders because copies are issued to convoy operating personnel, traffic regulating personnel, and traffic control posts. For security reasons,

it may not be desirable to include dates or locations. Security classification is given in accordance with contents of the table; it is not necessarily the same as that of the operation order. If the table is issued by itself and not as an annex to a more detailed operation or administrative order, it must be signed and/or authenticated in the same manner as other orders.

b. The beginning of the table includes general information common to two or more

serials, e.g., security classification, maps, average speed, traffic density, halts, main routes to the start and release points, and information about other critical points. Information concerning the routes and critical points is normally described by grid references, codewords, etc., and, if necessary, may be numbered or lettered for ease of reference to the columns in the table. The remainder of the table includes information concerning each individual serial and is arranged in tabular form. A sample road movement table is shown below.

(SECURITY CLASSIFICATION)

Annex _____ to _____ (Formation/Unit)
 Operation Order No. _____
 Dated _____

Maps _____

1. Average speed
 2. Traffic density
 3. Halts
4. Routes (between start points and release points may be indicated by code—red, green, etc.)
5. Critical points¹
 a. Start points
 b. Release points
 c. Other critical points
6. Main routes to start points
 7. Main routes from release points
- These routes and points may be described by grid references, code words, etc., and if necessary, numbered or lettered for ease of reference in the columns below.

Serial ² (a)	Date (b)	Unit formation (c)	No. of vehicles (d)	Load class of heaviest vehicles (e)	From (f)	To (g)	Route (h)	Route to start point (j)	Critical points ¹			Route from release point (n)	Remarks ³ (o)
									Ref (k)	Due (hrs) (l)	Clear (hrs) (m)		
1	23 Oct	46 Trans Co 51 Trans Co (Lt Trk)	90	21	Marseille	Montelimar	N 113 N 538 N 7	City	Marseille Salon Plan-Orgon Avignon Orange Pierralatte Montelimar	0800 0935 1016 1059 1150 1250 1330	0818 0935 1034 1117 1208 1308 1348	N 540	Return to Marseille immediately after unloading as Serial 1A.
2	23 Oct	67 Trans Co 70 Trans Co (Lt Trk)	120	21	Marseille	Montelimar	N 113 N 538 N 7	City	Marseille Salon Plan-Orgon Avignon Orange Pierralatte Montelimar	0820 1003 1044 1127 1218 1318 1358	0851 1026 1107 1150 1241 1341 1421	N 540	Relieved from attachment upon closing in Marseille.
3	23 Oct	89 Trans Co 90 Trans Co (Med Trk)	115	21	Marseille	Montelimar	N 113 N 538 N 7	N 8	Marseille Salon Plan-Orgon Avignon Orange Pierralatte Montelimar	0901 1036 1117 1201 1426 1526 1605	0925 1100 1141 1359 1450 1550 1629	N 540	Halt in place south of Avignon. Resume march at 1335 hours.

¹ Critical points are selected points along the route used for reference in giving instruction. These points include start point, release point, and other points along the route where interference with the movement may occur or where timing is critical.

² A movement serial is an element or group of elements within a series and in this table has a numerical designation for convenience in planning, scheduling, or control of movement.

³ Information which is common to two or more serials will be given in the beginning of the table, items 1-7.

SAMPLE ROAD MOVEMENT TABLE

c. A strip map (fig. 3-23) may also be published as an annex to an operation order. When a strip map is used, its details should correspond to the data in the road movement table and it should be distributed to the lowest practical level.

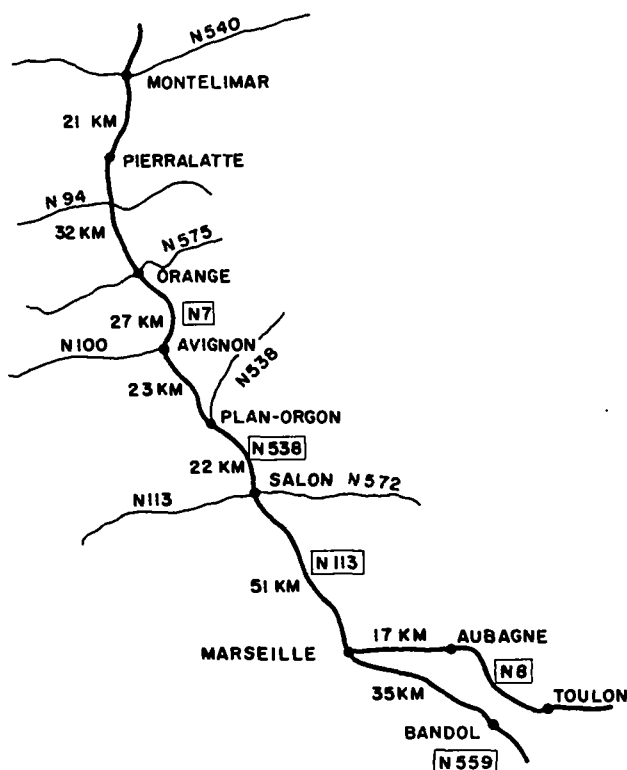


Figure 3-23. Sample strip map.

3-26. Convoy Commander's Checklist

If each item listed below is checked and acted upon carefully by the convoy commander before departure time, the chances of neglecting some important arrangement will be minimized.

- a. Where is start point? _____ Release point? _____
- b. What route is to be used? _____
- c. Has reconnaissance been made and condition of route determined? _____
- d. Can bridges and defiles safely accommodate all loaded and/or tracked vehicles? _____

e. Are critical points known and listed on strip maps? _____

f. Has the size of serials been determined? _____

g. Has the size of march units been determined? _____

h. What will be the rate of march? _____

i. What is the vehicle interval on open road? _____ In built-up areas? _____ At halt? _____

j. Type of column? _____

k. Has provision been made for refueling, if required? _____

l. Has a suitable bivouac site been selected, if required? _____

m. Have suitable rest and mess halt areas been selected, if required? _____

n. Is road-movement table needed? _____ Prepared? _____ Submitted? _____

o. Have convoy clearances been obtained? _____ What date? _____

p. Is escort required and has it been requested? _____

q. Are spare trucks available for emergencies? _____

r. Are vehicles fully serviced, clean, and ready for loading? _____

s. Is load proper, neat, and balanced? _____

t. Are drivers properly briefed? _____ By whom, when? _____ Strip maps furnished? _____

u. Is convoy marked front and rear of each march unit? _____

v. Are guides in place? _____ Have arrangements been made to post guides? _____

w. Are blackout lights functioning? _____

x. Are maintenance services alerted? _____

y. Is maintenance truck in rear? _____ Are medics in rear? _____ Plan for casualties? _____

z. Are all interested parties advised of ETA? -----

aa. Is officer at rear of convoy ready to take necessary corrective action such as investigating accidents and unusual incidents and changing loads? ----- Who is trail officer? -----

ab. Is there an entrucking plan? ----- Who is responsible? -----

ac. Is there a detrucking plan? ----- Who is responsible? -----

ad. Has a plan been made for feeding personnel? -----

ae. Have times been established for entrucking or loading? -----

af. Has time been established for formation of convoy? -----

ag. Have times been established for detrucking or unloading? -----

ah. Has time been established for releasing trucks? ----- Who is responsible? -----

ai. Is there a carefully conceived plan known to all personnel in the convoy that can be used in case of attack? -----

aj. Is a written operation order on hand, if required? -----

ak. Will a log of road movement be required at end of trip? ----- Are the necessary forms on hand? -----

al. Has weather forecast been obtained? -----

am. Do all personnel have proper clothing and equipment? -----

an. Is there a communications plan? -----

3-27. Convoy Commander's Report

The convoy commander prepares this report after a move has been completed and normally submits it to his immediate superior officer. The sample report below may be used as a guide. However, the report may be submitted in the form of a strip map, with an appropriate legend attached.

FORWARD LOAD

420 Trans Bn (Trk)	4401 Trans Co. (Lt Trk)
7A26FEB23 (Convoy No.)	Twelve 2½-ton (No. and type of task vehicles)
	16 Feb 62 (Date)

TIME:

Convoy departed SP	0621
Convoy departed 1st loading point	0800
Convoy arrived at 1st loading point	0630
Time at 1st loading point	1 hr 30 min
Arrived at highway regulation point (HRP)	1200
Departed HRP	1205
Departed 1st unloading point	1245
Arrived at 1st unloading point	1212
Time at 1st unloading point	33 min

SUPPLIES AND PERSONNEL:

Cargo (short tons)	50.2
Class of supplies	I
Personnel	0

DISTANCE:*

Speedometer reading of lead vehicle (1st loading point)	21,324
Speedometer reading of lead vehicle (SP)	21,322
Total forward (no load)	2
Speedometer reading of lead vehicle (1st loading point)	21,381
Total forward (loaded)	57

REMARKS:

SP—Company area, RJ 124/167
Weak bridge 6.4 miles east of 1st loading point. Road generally in poor condition between SP and 1st unloading point.

RETURN LOAD

TIME:

Departed 2d loading point	1300
Arrived at 2d loading point (same as 1st unloading point)	1245
Time at 2d loading point	15 min

*For explanation of footnote see end of sample report.

Departed 2d unloading point ... 1415
 Arrived at 2 unloading point ... 1400
 Time at 2d unloading point ... 15 min

SUPPLIES AND PERSONNEL:

Cargo (short tons) ... 10
 Class of supplies ... II and IV
 Personnel ... 120

DISTANCE:*

Speedometer reading of lead vehicle (2d unloading point) ... 21,396
 Speedometer reading of lead vehicle (2d loading point) ... 21,381
 Total return (loaded) ... 15
 Speedometer reading of lead vehicle (SP) ... 12,436
 Total return (no load) ... 40

REMARKS:

Road in excellent condition between 2d loading point and SP.

ROUND-TRIP DATA**TIME:**

Time returned to SP ... 1654
 Total round-trip time ... 10 hr 33 min
 Total travel time (including halts) ... 8 hr
 Total loading time ... 1 hr 4 5min
 Total unloading time ... 48 min

SUPPLIES AND PERSONNEL:

Cargo (short tons of Class I) ... 50.2
 (short tons of Class II and IV) ... 10
 Personnel ... 120

DISTANCE:*

Total distance (loaded) ... 72
 Total distance (unloaded) ... 42
 Total round-trip distance ... 114

REMARKS:

*Distances shown are in miles (multiply by 1.609 to convert to kilometers). Average rate of march=14.2 mih=22.9 kmih. Ton-miles: Forward—2,861; Return—150. Passenger—miles: Forward—0; Return—1,800.

s/Thomas A. Young

(Signature—convey commander)

2d Lt, 4401 Trans Co (Lt Trk)

(Rank or grade and organization)

3-28. Convoy Clearance

A convoy clearance request usually is required from a unit or organization that is planning a move by convoy. The information required varies according to local SOP and regulations. The sample outline below shows the information usually required by any authority that issues road clearances. When available, DD Form 1265 should be used. In a field army, the traffic headquarters normally determines routes to be used and issues road clearances.

From: S3 1429 TTBn

Phone: Barkersville 1429

Time and date: 261530 Oct 61

Authority for movement: MO 341, HQ TALOG, dated 19 Oct 61

Convoy No: 12B

Unit name or serial No.: 4406 T Car Co

Personnel: 4 Off 98 EM

Total number of vehicles: 51 trks, 31 tlrs

Type and number of vehicles: thirty-eight 1/4-ton trks, twenty-five 1/4-ton tlrs, one 3/4-ton trk, four 1 1/2-ton trks, eight 2 1/2-ton trks, six 1-ton tlrs

No. of serials: 3

Vehicles by type and number in serials (do not show control, mess, or maintenance vehicles):

(1) Two 2 1/2-ton trks, twelve 1/4-ton trks, one 1/2-ton trk, two 1-ton tlrs, eight 1/2-ton tlrs

(2) Same as 1st serial

(3) Same as 1st serial

Vehicle Distance: $\frac{60}{\text{(yards)}}$ $\frac{55}{\text{(meters)}}$

Average length of vehicles and/or combinations: $\frac{10}{\text{(yards)}}$ $\frac{9}{\text{(meters)}}$

Gap between serials:

Distance $\frac{2935}{\text{(yards)}}$ $\frac{2684}{\text{(meters)}}$ Time $\frac{5}{\text{(min)}}$

Length of serials:

Distance $\frac{990}{\text{(yards)}}$ $\frac{905}{\text{(meters)}}$ Time $\frac{1.69}{\text{(min)}}$

Total length of convoy:

Distance $\frac{8840}{\text{(yards)}}$ $\frac{8043}{\text{(meters)}}$ Time $\frac{15}{\text{(min)}}$

Cargo and tonnage²: 36 tons of baggage and organizational equipment.

Outsized or overweight loads: None

SP: Barkersville

Scheduled time and date of departure: 290700 Oct 61

Proposed route: Barkersville, RJ 261, Kennedy, Kleburg, Exeter

Destination: Exeter

Estimated time and date of arrival: 291900 Oct 61

Rate of march:	20	32
	(mih)	(kmih)

Scheduled halts: 15 min RJ 261; 1 hr Kennedy; 15 min Kelburg

Scheduled bivouacs: Arrive NA Depart: NA

POL points (determined by staff transportation officer): NA

Highway regulation (determined by staff transportation officer): Advised Sgt Harris in office of staff transportation officer, 261015 Oct 61. Clearance granted by Lt Brown, office of staff transportation officer, 261230 Oct 61.

Critical points:

<u>Name of Point</u>	<u>ETA</u>	<u>ETD</u>
RJ 261	0900	0915
Kennedy	1215	1315
Kleburg	1615	1630
Exeter	1900	

Remarks³:

1. POL points not needed. Convoy will be refueled by tankers during halt at Kennedy.

2. Unit commander will insure strict compliance with all SOP and with all highway regulation and control procedures issued by competent authority.

s/George A. Harkins
(Signature)

GEORGE A. HARKINS

Capt, S3 1429 TTBn
(Grade, title, and organization)

² If cargo includes explosives, include data required by local SOP and/or regulations.

³ Remarks should include statement of nature and quantity of all logistical support required.

3-29. Traffic Headquarters

a. Mission. The traffic headquarters coordinates the actual use of a road net to meet operational requirements. The traffic headquarters is normally established at division or higher levels.

b. Functions. The normal functions of a traffic headquarters include—

(1) Maintaining a situation map of the road net showing current data on road conditions.

(2) Implementing priorities established by the commander of highway movements.

(3) Receiving requests for highway routings and schedules from units within its area of jurisdiction.

(4) Consolidating itineraries and road movement tables and issuing movement credits as necessary.

(5) Receiving, coordinating, and disseminating information on highway movements into its area of jurisdiction.

(6) Coordinating movements terminating outside its area of jurisdiction with other headquarters.

c. Organization. The traffic headquarters is normally organized in the combat service support element supporting the tactical command. It is established under control of the G4. A highway planning officer is charged with operating the traffic headquarters.

3-30. Highway Schedule Request

This request is submitted by a unit desiring to use certain parts of the highway at specified times. Clearances are normally issued by post transportation officers, and highway regulation is not required. A sample request that shows the information usually required is given below.

1. FOR (UNIT): 4401st Trans Company (Light Truck)
2. ORIGIN: Fort Eustis, Va. DESTINATION: Camp A.P. Hill, Va.
3. DESTINATION INSTALLATION: Moss Neck area
4. VEHICLES BY TYPE:

Wheeled				Tracked	Total
Smaller than 2½-ton	2½-ton	5-ton	Larger than 5-ton		
5	45	None	1	None	51

REMARKS: Vehicle larger than 5-ton is a truck, 6-ton 6x6 wrecker

5. LIMITATIONS (SPECIAL SCHEDULING): (a) LGTH: NA (b) WIDTH: NA (c) HGT: NA (d) WT: NA
6. (a) No. SERIALS: 3 (b) INTERVAL: 5 min (c) No. MARCH UNITS: 9 (d) INTERVAL: 2 min within serials
 (e) TIME LENGTH: 28 min (f) RATE OF MARCH: 20 mih (g) TYPE OF CARGO: None (training mission)
 h) TONS: None
7. CONVOY COMMANDER: 1st Lt James E. Brown
8. ROUTE AND SCHEDULE:

(a) Critical points	(b) Arrive	(c) Clear	(d) Route	(e) MP escort required	(f) Remarks
Main Gate, Ft Eustis, Va.	210600 May 62	210628 May 62	Rts 60, 238, 168, North	Yes	
RJ Routes 168 and 30	210700 May 62	210728 May 62	Rts 30 and 33, East	No	
RJ Routes 33 and 17	210800 May 62	210828 May 62	Rt 17, North	No	

9. PERSONNEL, IF LOGISTICAL SUPPORT REQUIRED: (a) OFF None (b) EM None (c) OTHER None

10. SUPPORT REQUIRED: None

REQUESTED BY: Maj John P. Doe
 DATE: 16 May 1962 TIME: 0800
 MOVEMENT No: 23-2-62
 ORGANIZATION: 23d Transportation Group (Truck)
 RECEIVED BY: Lt Brown (Transportation Office)

3-31. Vehicle Loading

a. *Responsibility.* The driver is responsible for his vehicle being loaded properly.

b. *Rules for Loading* (fig. 3-24).

(1) Place heavy supplies at the bottom of the load and distribute evenly over cargo floor.

(2) Place the load so that it will not shift; distribute the weight equally.

(3) Do not distribute load loosely or build it up too high. High, loosely distributed

loads cause swaying, make the vehicle difficult to handle, and increase the danger of losing the cargo or overturning the vehicle.

(4) If the truck has an open body, put a tarpaulin, when practicable, over the cargo to protect it against sun, dust, rain, or pilferage.

(5) If possible, place barrels and drums on their sides—parallel with the length of the truck and brace and pyramid them. If the possibility of leakage does not permit this placement, set the drums' upright. This latter

arrangement does not permit the loading of as many drums in the same space.

(6) Combine boxed, crated, and packaged cargo, as far as possible, with like items or items of combining shapes.

(7) Load sacked cargo separately, or so as not to risk its being punctured by odd-shaped or sharp-edged items; stack it in overlapping layers to prevent shifting.

3-32. Vehicle Capacities and Capabilities

The figures below should be used for planning purposes only. They are based upon experience gained in the field and are averages for the various makes and models of the equipment listed. Weather, roads, terrain, and tactical situation must also be considered.



WRONG



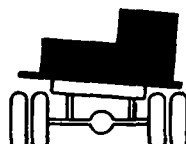
RIGHT

The right vehicle for the right job.



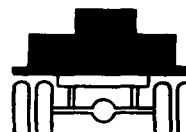
WRONG

This overloads trailer rear wheels, brakes will not brake properly, rubber scuffs away. Distribute the load over the full trailer floor.



WRONG

This overloads one spring and set of tires. Brakes lock on the light side, cause skids.



RIGHT

Nothing overloaded, frame will not twist and loosen cross-member rivets.



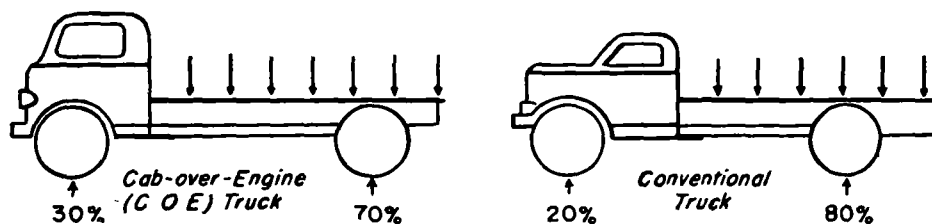
WRONG



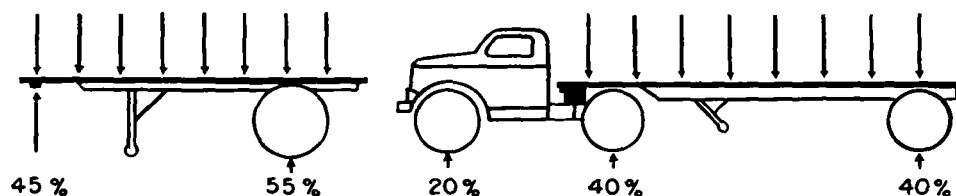
RIGHT

This overloads and shortens tire life, bends the truck rear-axle housing. Applying the trailer brakes may lock the wheels and cause flat spots and skidding.

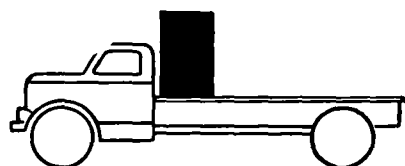
Figure 3-24. How to load a truck.



Tires, axles, frame, etc., are designed to carry a load distributed as above.

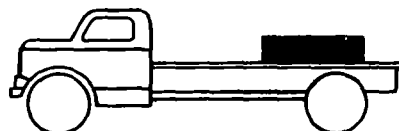


Distribute trailer loads equally between the rear tires and the fifth wheel. This transfers the load to the tractor.



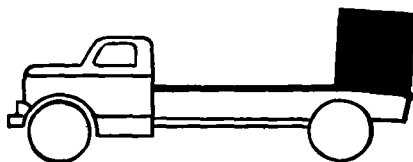
WRONG

This will bend the frame, overload front tires, making steering harder.



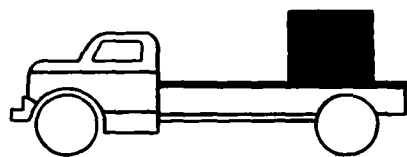
RIGHT

Place heavy part of load near rear axle for proper tire loading and to keep frame from bending.



WRONG

This kind of weight distribution bends the frame, overloads rear tires, and makes steering almost impossible.



RIGHT

Set a concentrated load just ahead of the rear axle with, if possible, the longest side on the floor.

Figure 3-24—Continued.

a. Local and Line Hauls.

Type of equipment	Avg load per veh trip	Loading and un- loading time (hr) per round trip	Local hauls ¹			Line hauls ²				
			Avg distance forward		Round trips per veh per day	Distance in the hr		Avg daily distance capability		
			Mi	Km		Mi	Km	Mi	Km	
Truck, cargo:										
2½T, 6x6 -----	4 tons	2½	15	24	4	15	24	125	201	
5T, 6x6 -----	6 tons	2½	15	24	4	15	24	125	201	
Semitrailer:										
12T, S&P -----	12 tons	2½	15	24	4	15	24	125	201	
Gas tank, 12T, 4W -----	5,000 gal.	2½	15	24	4	15	24	125	201	
Refrig, 7½T, 2W -----	6 tons	2½	15	24	4	15	24	125	201	
Low-bed wrecker, 12T, 4W -----	1 missile	2½	15	24	4	15	24	125	201	
Tank trans, 50T -----	50 tons	2½	15	24	4	11	18	90	145	

¹ Includes port and beach clearance.² Figures are for long-range planning. Multiply by 4/3 or 1.33 for short-range planning quantities.

b. Payload Capacities.

Type of equipment	Maximum cargo loads		Men w/individ equip- ment ^a
	Off road	Highway	
Truck, cargo:			
2½T, 6x6 ---	2½ tons	5 tons	16
5T, 6x6 -----	5 tons	10 tons	18
Semitrailer:			
12T, S&P ---	12 tons ^b	18 tons	50 ^c
12T, Van, 4W	12 tons	13 tons	NA
Gas tank, 12T, 4W.	3,000 gal.	5,000 gal.	NA
Refrg, 7½T, 2W.	6 tons ^b	7½ tons	NA
Low-bed wrecker, 12T, 4W.	1 missile	1 missile	NA
Tank trans, 50T.	40 tons ^b	50 tons	NA

^a Does not include driver. For distance greater than 75 miles, the figure should be reduced.^b Not generally used for this type of operation.^c Recommended for emergency use only.

c. Vehicle Availability. In advance highway

d. Capabilities of Truck Companies.

Type of equipment	Short tons daily	Local ^a	Type of haul		Line ^b	Short-ton- kilometers daily
			Short ton-miles daily	Metric ton- kilometers daily		
Truck, cargo:						
2½T, 6x6 -----	720		653	22,500	32,843	36,180
5T, 6x6 -----	1,080		980	33,750	49,264	54,270
Semitrailer:						
12T, S&P -----	2,160		1,960	67,500	98,528	108,540
Gas tank, 12T, 4W ---	900,000 gal."	3,406,500		84,375 ^d	123,161	135,000
Refrg, 7½T, 2W ----	1,080		980	33,750	49,264	54,270
Low-bed wrecker, 12T, 4W.	40 large missiles ^c	-----		20 large missiles ^c	-----	-----
Tank trains, 50T -----	3,600		3,266	81,000	118,234	130,500

^a Based on vehicle availability × avg load per veh trip × round trips per veh per day.^b Based on vehicle availability × avg load per veh trip × avg daily distance capability.^c Tonnage figures not applicable.^d Based on liquid POL weighing 6 lb (2.7216 kg) per gal.

transport planning, availability means the average number, or percent, of vehicles in a unit that can be operated continuously for 20 hours during each 24-hour period. The table below gives planned availability figures. Availability figures are greater than those shown in the table for a longer daily operation or for a specific task such as a short one-lift haul. The planning figure must not be confused with actual availability, which is obtained from vehicle records and reports.

Unit	Task vehicles assigned	Vehicle availability		
		Advance planning ¹	Target ² (24-hour day)	Spot tasks
Trans light trk co -	60	45	50	57
Trans med trk co -	60	45	50	57
Trans hvy trk co --	24	18	20	23
Trk pools -----	Any	75%	83%	95%

number

¹ Also used when involved in particularly rigorous operations remote from adequate maintenance, or when actual operating conditions cannot be determined.² With well-trained and disciplined personnel, good operating conditions, and adequate maintenance support.

3-33. Vehicle Unitized-Load Capabilities

Load	Vehicle			
	<i>2½T cargo truck^a Sides in place, crane-loaded</i>	<i>Sides removed, forklift-loaded</i>	<i>10T stake and platform trailer Sides in place, crane-loaded</i>	<i>Sides removed, forklift-loaded</i>
Cargo net -----	3	Not recommended	6	Not recommended
Cargo transporter, type 2 -----	1 lengthwise	1 lengthwise	3 lengthwise	4 crosswise ^b
Stevedore pallet -----	2 crosswise	4 lengthwise	6 crosswise	8 lengthwise: 2 rows of 4 ^c
Unitized pallet -----	3 crosswise	5: 4 lengthwise; 1 crosswise.	7 crosswise	10 lengthwise: 2 rows of 5 ^c
Warehouse 4x4 pallet -----	3	3	6	12: 2 rows of 6

^a Some 2½-ton, 6×8, cargo trucks have fender wells which project into the cargo space. In such cases, a level platform for the storage of a unitized cargo can be obtained by fitting a frame of 2 by 4 or 4 by 4 timbers flat in the cargo bed between the fender wells.

^b May be loaded by crane.

^c Increase by one for 12-ton stake and platform trailer.

3-34. Motor Vehicle Shipments of Hazardous Cargo

a. The following measures must be enforced to prevent fire:

(1) Smoking must be prohibited within 50 feet (15 m) of a vehicle loaded with explosives or flammable liquids. Open flames such as those produced by striking matches and using cigarette lighters, torches, etc., must be prohibited within 100 feet (30 m) of any motor vehicle loaded with explosives or gasoline.

(2) Two fire extinguishers, properly filled, should be provided, one inside the cab and one outside, on the driver's side.

(3) All personnel should be instructed in the proper use of fire extinguishers and, where practicable, the instruction should be supplemented by demonstrations.

(4) If a truck catches on fire, all trucks should be moved away from the vicinity of the fire and all traffic stopped. Every effort should be made to warn inhabitants living in the vicinity of the danger.

(5) When loading or unloading trucks, explosives must not be placed in the vicinity of the exhaust.

(6) Ignition and lighting systems should be properly insulated and inspected frequently to insure that danger from short circuits is eliminated.

(7) Every effort should be made to prevent leaks in gasoline tanks, fuel lines, and carburetors. When a leak is discovered, the

truck should be unloaded and moved to a safe distance before repairs are made.

(8) Oil and grease thrown from parts should not be allowed to accumulate on the truck body, engine, or other places where a fire hazard would result.

b. Motor vehicles transporting explosives or gasoline must not be driven past fires of any kind until it has been ascertained that the fire can be bypassed safely.

c. Advance reconnaissance and contact with civilian traffic officials are essential. Whenever possible, routes selected should avoid heavy traffic and large cities.

d. Loitering should not be permitted in the vicinity of a vehicle in convoy.

e. When a truck breaks down, it should be moved off the road or as far to the side as possible and, pending the arrival of an empty truck or repair party, left in charge of a guard.

f. Fuzes and detonating devices must not be carried in the same truck with other explosives (fixed and semifixed ammunition are exceptions).

g. The interior of the truck body should be lined so that every portion of the lining with which a container may come in contact is of wood or other nonsparking material.

h. Loads should be braced and stayed to prevent shifting.

i. A truck loaded with explosives or gasoline must never be towed or pushed except when a

disabled truck must be moved to the side of the road.

j. Hourly halts should be made to inspect loads and vehicles.

k. Motor vehicles transporting explosives on public roads or highways must be marked with placards bearing the word EXPLOSIVES in letters at least 8 inches (21 cm) high. The placards must be prominently located on each side, and on the front and rear of the truck.

l. A motor vehicle transporting explosives or gasoline must not be left unattended upon any public street or highway.

m. The vehicle motor must not be running when explosives or gasoline are being loaded or unloaded.

n. When a truck has an open body, a tarpaulin must be used to protect the cargo from rain or the direct rays of the sun.

o. The entire cargo of explosives or ammunition must be transported within the body of the truck. The truck tailboard or tailgate must be closed and secured.

p. Cargo such as dynamite and certain other explosives must be protected from intense cold, which can cause the explosive to deteriorate or become dangerous. Freezing characteristics of the cargo must be determined be-

fore transporting such cargo in temperatures below 32° F. If necessary, insulated vans must be used.

q. Motor vehicles transporting chemical agents and hazardous chemicals over public highways must conform with ICC regulations. In general, such vehicles will be placarded on the rear, front, and on each side with reflecting placards indicating the degree of hazard. For detailed information see AR 55-355 and appropriate carrier tariffs.

3-35. Vehicle Missile-Carrying Capabilities

The missile-carrying capabilities of certain types of vehicles normally found in highway units are given in *a* and *b* table below. In each case, either weight or volume is the limiting factor. To achieve the loads indicated, it may be necessary to raise or remove the tops of some trucks and trailers. The loads given do not exceed width dimensions of the vehicles, except in some cases for low-bed and flat-bed trailers. Some of the special equipment used to transport one complete round or the major components thereof is listed in *c*, table below. In the tables, column A indicates the number of packaged missiles or indicated component that one vehicle can transport. Column B shows the number of vehicles required to transport one packaged missile or indicated component.

a. *Transportation Light Truck Company (TOE 55-17).*

Vehicles	Nike-Hercules		Little John		Sergeant		Honest John		Pershing		SS-10		SS-11		Hawth	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Trailer:																
Cargo, ¼T, 2W, M100 -----	---	---	---	---	---	---	---	---	---	---	2	1	2	1		
Cargo, 1T, 2W -----	---	---	---	---	---	---	---	---	---	---	6	1	8	1		
Cargo, 1½T, 2W, M104 -----	---	---	1	1	---	---	---	---	---	---	16	1	14	1		
Flat-bed, guided missile, M261, 3,245 lb -----	---	---	1	1	---	---	---	---	---	---	17	1	20	1	1	1
Truck:																
Cargo, 2½T, 6x6, M35 -----	---	---	2	1	---	---	---	---	---	---	26	1	28	1		
Cargo, 2½T, 6x6, M135 -----	---	---	2	1	---	---	---	---	---	---	20	1	20	1		
Cargo, 5T, 6x6, M54 -----	---	3	2	1	---	2	1	1	---	4	30	1	32	1	3	1
Cargo, 5T, 6x6, M55 ¹ -----	---	3	4	1	---	2	1	1	---	3	48	1	48	1	3	1

b. *Transportation Medium Truck Company (TOE 55-18).*

Semitrailer:																
6T, 2W, S&P, M118 -----	---	2	4	1	---	2	1	1	---	3	54	1	52	1	3	1
10T, 2W, S&P -----	1	1	6	1	---	2	1	1	---	2	60	1	60	1	6	1
Cargo, 12T, 4W, M127 -----	1	1	6	1	1	1	2	1	---	2	66	1	64	1	6	1
Low-bed wrecker, 12T, 4W, M269 -----	1	1	10	1	1	1	2	1	1	1	90	1	111	1	7	1
Low-bed wrecker, 12T, 4W, M270 -----	1	1	10	1	1	1	2	1	1	1	127	1	152	1	7	1
Lowbed, 25T, 4W, M172 -----	1	1	12	1	2	1	3	1	1	1	96	1	108	1	12	1

c. *Special Transport Equipment.*²

Trailer, rocket, XM449 -----	---	---	1	1												
Truck, 2½T, 6x6, M45E3, with launcher, XM398E1 -----	---	---	---	---												
Semitrailer (Sergeant warhead and forebody) -----	---	---	---	---	1	1										
Semitrailer (Sergeant motor) guidance, and fin -----	---	---	---	---	1	1										
Truck-mounted launcher, M289 (Honest John rocket) -----	---	---	---	---	---	---	1	1								
Truck-mounted launcher, M386 (Honest John rocket) -----	---	---	---	---	---	---	1	1								
Erector-launcher, GM Transportable (Pershing) -----	---	---	---	---	---	---	---	---	1	1						

¹ Requires special authorization. Normally assigned to Ordnance special ammunition companies.

² Equipment shown does not include all ground servicing equipment.

3-36. Computing Truck Unit Requirements

a. One-Lift Hauls. To determine the number of truck companies required to move a given number of tons in one lift, use the following formula:

$$\frac{\text{Tons to be lifted}}{\text{Tons per veh} \times \text{veh availability per Co}} = \text{truck companies required}$$

Example. Determine number of light truck companies required to move 2,700 tons in 1 lift. Assuming: 4 = tons per 2½-ton, 6x6 truck
45 = vehicle availability per company

Substitute in formula:

$$\frac{2,700}{4 \times 45} = 15 \text{ companies}$$

b. Sustained Forward Hauls (Continuous Operation Using Relays). In sustained forward hauls, trucks return for additional loads, and it is necessary to consider turnaround time and the daily operating time. To determine the number of truck companies required to move a given forward tonnage daily, use the formula below.

$$\frac{\text{Daily forward tonnage} \times \text{turnaround time in hours}}{\text{Tons per veh} \times \text{veh available per Co} \times \text{operating time in hours (daily)}} = \text{truck companies required}$$

Example. Determine the number of medium truck companies equipped with semitrailers, 12-ton, stake and platform, required to move an average tonnage of 4,800 short tons daily for a round-trip distance of 435 miles.

Assuming: 12 = tons per vehicle
45 = vehicle availability per company
20 = hours operating time daily
10 = miles in the hour
1 = hour for each relay terminal operation (average 1 terminal per 125 miles)

First, compute turnaround time:

$$\text{TT} = \frac{\text{round-trip distance}}{\text{rate of march}} + \text{delays} = \frac{435}{10} + 2 = 45.5 \text{ hours}$$

Then substitute in the formula:

$$\frac{4,800 \times 45.5}{12 \times 45 \times 20} = 20.2 \text{ or } 21 \text{ companies}$$

c. Sustained Hauls (Continuous Operation).

In sustained forward hauls using only trucks, not semitrailers in relays, it is necessary to consider operating turnaround (including loading and unloading) and the daily operating time. To determine the number of truck companies required to move a given forward tonnage daily, use the following formula:

$$\frac{\text{Daily forward tonnage} \times \text{operating turnaround}}{\text{Tons per veh} \times \text{veh available per Co} \times \text{operating time in hours (daily)}} = \text{truck companies required}$$

Example. Determine the number of light truck companies, equipped with 2½-ton trucks, required to move an average tonnage of 5,000 short tons daily for a round-trip distance of 52 kilometers.

Assuming: 4 = tons per vehicle
45 = vehicle availability per company
20 = hours operating time daily
2.5 = hours for loading and unloading
16 = kilometers in the hour

First, compute operating turnaround time:

$$\text{TT} = \frac{\text{round trip distance}}{\text{rate of march}} + \text{delays} = \frac{52}{16} + 2.5 = 5.75 \text{ hours}$$

Then, substitute in the formula:

$$\frac{5,000 \times 5.75}{4 \times 45 \times 20} = 7.9 \text{ or } 8 \text{ companies}$$

3-37. Motor Movement in Snow

Depth of snow (inches)	Special measures required for movement
3 -----	None.
9 -----	Rear chains.
6-18 -----	Chains on all wheels; traction devices on leading vehicles to break the trail. Under some snow conditions, a snowplow may be required to break a path for wheeled vehicles.
18 or more --	Snowplow required.

3-38. Time Elements in Supply Operations

The time elements given below represent an approximated average under combat conditions and should be used as a guide only when actual experience figures are not available.

	Minutes	
	Daylight	Darkness
<i>Class I</i>		
Unloading rations for one division at class I distributing point and preparing for distribution to battalions or units of similar size -----	100	125
Distributing class I supplies to battalion or unit of similar size by higher echelon at one distributing point -----	20	20
Distributing class I supplies to separate battalion or unit of similar size by higher echelon -----	15	15
Preparing 1 day's class I supplies for issue at battalion or battalion class I distributing point -----	30	45
Physically distributing battalion supply agencies 1 day's class I supplies (transfer or loads) to kitchen -----	15	20
Unloading kitchen equipment from trucks, setting up, and being prepared to begin cooking (or vice versa) -----	20	20
Breaking down subsistence into three meals at kitchen (breakdown accomplished by mess personnel) ---	15	20
Preparing, cooking, and being ready to serve a hot meal, starting with a hot kitchen. (Issue of subsistence for cold noon meal included if hot meal being prepared is breakfast.) -----	120	150
Serving a hot meal to troops from a kitchen truck with majority of men being served at the truck -----	45	60
Serving a hot meal to troops by means of carrying parties (when kitchen is located within a 1,000-yard radius of company) -----	90	120
<i>Class II and IV*</i>		
Loading 2½-ton trucks at distributing or supply points:		
Class II and IV (except fortification materials) -----	30	30
Fortification materials, class IV -	50	50
Loading 1½-ton trailers:		
Class II and IV (except fortification materials) -----	12	12
Fortification materials, class IV -	30	30
<i>Class V*</i>		
Loading 2½-ton trucks at ammunition distributing or supply points -----	30	50
Loading 1½-ton trailers -----	12	30
Unloading 2½-ton ammunition vehicles -----	15	30
Unloading 1½-ton trailers -----	6	12

*When trucks and trailers are overloaded, increase the time by the percentage of the overload.

3-39. Water Supply

a. Water Requirements. Values given are for planning purposes in temperate zones. For extremes of heat or cold, requirements vary considerably from these values.

Truck	Terrain	Gallons per day
2½-ton, 6x6 ---	Level, rolling -----	½
	Mountainous -----	½ to 1
5-ton, 6x6 -----	Level, rolling -----	1
	Mountainous -----	1 to 2

b. Vehicle Carrying Capacities. A full 5-gallon water can weighs 50 pounds; the volume of the can is 1.4 cubic feet.

Vehicle	Carrying capacity (full 5-gal. cans)	
	Off highway	On highway
¼-ton trailer -----	10	20
1½-ton trailer -----	60	120
2½-ton truck, M35 -----	100	200
2½-ton truck, M135 -----	100	200
5-ton truck, M54 -----	200	370
12-ton semitrailer, M127 -----	480	593

3-40. Highway Capability Estimates

a. Definitions. The following definitions are applicable to this discussion of capacity and capability:

(1) *Traffic volume.* The number of vehicles, considering road conditions, vehicle type, and resulting rate of march attainable, that can pass one point in one direction using one lane in a specific period of time, expressed in vehicles per hour (VPH) or vehicles per day (VPD).

(2) *Basic capacity.* The maximum number of vehicles that can pass over a highway during a 24-hour period, based upon a safe operating vehicle speed and interval, considering vehicle and pavement types.

(3) *Operational capacity.* The maximum number of vehicles that can pass over a highway in a 24-hour period, derived from estimates of basic capacity with allowances for driver characteristics, unforeseen operational developments, vehicle casualties, driver changes, and essential preventive maintenance en route.

(4) *Practical daily capacity.* The maximum number of vehicles that can pass over a highway per day, considering highway characteristics and operating conditions.

(5) *Capability.* The maximum number of short tons of payload per day which can be moved over a highway, considering type of roadway, maintenance, hills, curves, weather, other traffic, types of vehicles used, and other limiting factors.

b. General. The capacity of a highway to support a normal or a maximum vehicular movement is determined by a number of factors: vehicle types and average loads, traffic data, type and width of surface and shoulders, base type and thickness, subsoil type and condition, curves and gradients, moisture and temperature, number of traffic lanes, and operational factors (tables 3-1—3-7). No one highway movement is apt to be affected by all of these basic factors. Conditions dictate which factors must be used to estimate the capability of a highway. Tonnage movement which exceeds the capacity of any part of the road net should not be planned unless reconstruction or heavy maintenance to increase the capacity of the inadequate highway section or bridge is also planned; otherwise, the load must be distributed on alternate routes. If an alternate route is not available or if the tonnage is not reduced, the planner can expect the highway or bridge to deteriorate rapidly and any sustained operation to be disrupted. In addition, maintenance vehicles and personnel may limit capacity by interference with the flow of traffic. A workable method for determining the tonnage capability of a highway is explained in *c*, *d*, and *e* below. Sufficient vehicle types (foreign or domestic) have been included to provide a basis for estimating the capability of any highway. This method is based on the assumption that the highway bridges (dimensions and supporting characteristics) are adequate, or will be improved to carry the estimated loads. Capabilities in table 3-8 may be used when specific and detailed highway information is not available. Capacity of a specific road may be quickly estimated without use of tables or other aids by determining traffic volume as described in *c* below.

c. Basic Factors. Simple estimation of traffic volume and resulting road capacity in vehicles or tons per given period of time:

(1) Rate of march is the primary controlling factor in this method of determining traffic volume; therefore, extreme care must be used in selecting a realistic rate of march. Traffic volume may be determined by using the following formula:

(a) *Meters:*

$$\text{Traffic volume in vehicles per hour} = 1000 \times \frac{\text{Rate of march (KMIH)}}{\text{Intervehicular gap (meters)}}$$

(b) *Miles and yards:*

$$\text{Traffic volume in vehicles per hour} = 1760 \times \frac{\text{Rate of march (MIH)}}{\text{Intervehicular gap (yards)}}$$

(2) To determine traffic volume in vehicles per day, multiply the result of the above formula by the anticipated number of operating hours per day.

(3) To determine road capacity in vehicles, multiply traffic volume by the number of usable lanes in one direction.

(4) To determine road capacity in tons, multiply road capacity in vehicles by the average payload in tons of the vehicle to be used.

(5) *Example.* Rate of march = 20 KMIH
Intervehicular gap = 100 meters
Usable traffic lanes in each direction = 2
Hours of operation per day = 24
Average payload per vehicle = 3 STON

$$\begin{aligned} \text{Traffic volume} &= 1000 \times \frac{20 \text{ KMIH}}{100 \text{ meters}} \\ &= 200 \text{ VPH or } 4,800 \text{ VPD.} \end{aligned}$$

$$\text{Road capacity in vehicles per day} = 4,800 \text{ VPD (volume)} \times 2 \text{ lanes} = 9,600 \text{ VPD}$$

$$\begin{aligned} \text{Road capacity in tons per day} &= 9,600 \text{ VPD (capacity)} \\ &\times 3 \text{ STON per vehicle} = 28,800 \text{ STON} \end{aligned}$$

d. Basic Factors.

(1) *Surface type* (table 3-1). The types of road surfaces and basic and operational capacities are shown in table 3-1. If the vehicle in question does not correspond exactly to one in the table, the analyst should select the basic or operational capacity for the vehicle that is most similar to the vehicle in question.

Table 3-1. Highway daily capacity: Basic and operational.

Surface type	Vehicle types (highway tonnage ratings)	Average speed		Vehicle interval		Capacity in vehicles per 24 hours for all traffic	
		(mph)	(kmph)	(ft)	(meters)	Basic ^a	Operational ^b
Cement concrete, bituminous concrete, intermediate bituminous and bituminous-surface treated.	3T trk (avg for 2-axle)	25	40	300	91	21,100	16,900
	5T trk -----	25	40	300	91	21,100	16,900
	10T trk or stlr -----	25	40	325	99	19,200	15,400
	18T stlr -----	25	40	375	114	16,800	13,400
	50T stlr -----	20	32	400	122	12,500	10,000
	admin veh -----	25	40	250	76	25,200	20,200
Waterbound macadam, gravel, and crushed stone.	3T trk (avg for 2-axle)	20	32	(c) 600	183	8,400	6,700
	5T trk -----	20	32	600	183	8,400	6,700
	10T trk or stlr -----	20	32	700	213	7,700	6,200
	18T stlr -----	20	32	700	213	7,700	6,200
	50T stlr -----	15	24	700	213	5,800	4,600
	admin veh -----	20	32	500	152	10,600	8,500
Improved earth -----	3T trk (avg for 2-axle)	20	32	(c) 800	244	6,300	5,000
	5T trk -----	20	32	800	244	6,300	5,000
	10T stlr -----	20	32	800	244	6,300	5,000
	18T stlr -----	20	32	800	244	6,300	5,000
	50T stlr -----	15	24	800	244	5,000	4,000
	admin veh -----	20	32	700	213	7,700	6,200
Unimproved earth --	3T trk (avg for 2-axle)	15	24	(c) 1,000	305	3,800	3,000
	5T trk -----	10	16	1,000	305	2,500	2,000
	10T trk or stlr -----	10	16	1,000	305	2,500	2,000
	18T stlr -----	10	16	1,000	305	2,500	2,000
	50T stlr -----	10	16	1,000	305	2,500	2,000
	admin veh -----	15	24	1,000	305	3,800	3,000

^a Basic capacity is based upon the assumptions that a 24-foot surface width (two lanes) is used; a 12-foot shoulder is on each side; there is straight and level alignment; surface and subsoil are in excellent condition; traffic control is provided; movements are sustained; and vehicles travel in both directions.

^b Operational capacity is approximately 80 percent of basic capacity.

^c Intervals increase as quality of surface decreases due primarily to the dust hazard.

(2) *Surface and shoulder width* (table 3-2). For a two-way movement, the ideal single highway is 24 feet wide and has shoulders at least 12 feet wide. The shoulder factor should be considered only for maintaining maximum capacity, not for increasing capacity. If there are no shoulders or if they are

less than 12 feet wide (7 feet for one-way movement), a reduction factor should be used. Table 3-3 is used if the widths of the surface and shoulder are not given separately and the width of the traveled way only is known. This may occur in connection with gravel or earth roads.

Table 3-2. Surface and shoulder width factors

Type of movement	Number of lanes	Surface		Shoulder	
		Width (ft)	Factor	Width (ft)	Factor
One-way	1	8	-----	0	-----
	1	9	-----	1	-----
	1	10	-----	2	-----
	1	11	-----	3	-----
	1	12	-----	4	-----
	1	12-18 ^a	-----	5	-----
	1	>18	-----	6	-----
	1	-----	-----	7	-----
	1	-----	-----	>7	-----
Two-way	2	18	-----	0	-----
	2	19	-----	1	-----
	2	20	-----	2	-----
	2	21	-----	3	-----
	2	22	-----	4	-----
	2	23	-----	5	-----
	2 or 3 ^c	24	-----	6	-----
	2 or 3	24-35	-----	7	-----
	2 or 3	>35	-----	8	-----
	2 or 3	-----	-----	9	-----
	2 or 3	-----	-----	10	-----
	2 or 3	-----	-----	11	-----
	2 or 3	-----	-----	12	-----
	2 or 3	-----	-----	>12	-----
	4	36	2.0	0-2	0.80
	4	42	2.2	2-7	0.90
	4	48	2.5	7-12	1.00
	4	-----	-----	>12	1.00
	4	-----	-----	>12	1.00

^a For pavement widths between 12 and 18 feet, consider $\frac{1}{2}$ the width over 12 feet as additional shoulder width.

^b For one-way movements on pavements more than 18 feet in width, the factor for half the actual pavement width will be selected, and will then be doubled to reflect the two lines of traffic that can effectively use pavements 18 feet or more in width.

^c Even though a road has three lanes, the capacity estimate should be based on two-lane traffic movement, thereby eliminating the inherent inefficiency and loss of capacity caused by three lanes of movement.

Table 3-3. Combined surface and shoulder factors when only width of traveled way is known

Width of traveled way (feet)	Factor		Width of traveled way (feet)	Factor	
	One-way movement	Two-way movement		One-way movement	Two-way movement
8	0.33		25	-----	0.71
9	0.36		26	-----	0.73
10	0.39		27	-----	0.75
11	0.42		28	-----	0.77
12	0.45		29	-----	0.79
13	0.46		30	-----	0.80
14	0.47		31	-----	0.82
15	0.48		32	-----	0.835
16	0.53		33	-----	0.84
17	0.58		34	-----	0.85
18	0.62		35	-----	0.86
19	0.65		36	-----	0.87
20	0.675	0.52	37	-----	0.87
21	0.675	0.55	38	-----	0.87
22	0.675	0.575	39	-----	0.87
23	-----	0.60	40	-----	0.87
24	-----	0.63	41	-----	0.875
	-----	0.66	42	-----	0.88
	-----	0.68	43	-----	0.90

Width of traveled way (feet)	Factor	
	One-way movement	Two-way movement
44	-----	0.92
45	-----	0.94
46	-----	0.96
47	-----	0.98
48	-----	1.00
49	-----	1.00
50	-----	1.00

(3) *Curve and gradient* (table 3-4). Curves and gradients affect the capacity of roads. Radius of simple curvature is measured from the center of the circle to the middle of the road. Gradient, or slope percentage, is the vertical rise to the horizontal distance traveled. The ruling grade of a road is the gradient used in determining the capacity of roads.

Table 3-4. Curve and Gradient Factors *

Curve radius (ft)	Radius of curvature Factors						Percent	Gradient Factors					
	3T trk	5T trk	10T stlr or trk	8T stlr	50T stlr	Admin veh		3T trk	5T trk	10T stlr or trk	18T stlr	50T stlr	Admin veh
<50	0.40	0.40	0.20	.20	.20	.65	<2	1.00	1.00	1.00	1.00		1.00
50	0.40	0.40	0.20	.20	.20	.65	2	1.00	1.00	1.00	1.00	.98	1.00
63	0.50	0.51	0.29	.25	.23	.78	2½	1.00	1.00	1.00	1.00	.97	1.00
75	0.60	0.63	0.38	.30	.27	.85	2¾	1.00	1.00	1.00	1.00	.95	1.00
88	0.70	0.71	0.44	.35	.31	.91	2¾	1.00	1.00	1.00	.99	.94	1.00
100	0.75	0.78	0.50	.41	.35	.94	2½	1.00	1.00	.99	.98	.93	1.00
113	0.78	0.83	0.55	.46	.40	.97	2½	1.00	1.00	.98	.97	.92	1.00
125	0.82	0.88	0.61	.54	.46	.98	2¾	1.00	1.00	.98	.96	.89	1.00
138	0.85	0.91	0.66	.60	.52	.99	2¾	1.00	1.00	.97	.94	.88	1.00
150	0.88	0.94	0.71	.65	.57	1.00	3	.99	1.00	.95	.93	.86	1.00
163	0.90	0.96	0.75	.71	.62	1.00	3¼	.98	1.00	.93	.91	.83	1.00
175	0.92	0.98	0.78	.74	.67	1.00	3½	.98	1.00	.91	.88	.81	1.00
188	0.94	0.99	0.82	.78	.71	1.00	3¾	.97	1.00	.88	.85	.78	1.00
200	0.95	0.99	0.86	.82	.75	1.00	4	.95	.99	.86	.82	.75	1.00
213	0.97	1.00	0.88	.85	.78	1.00	4¼	.94	.99	.83	.78	.71	1.00
225	0.98	1.00	0.91	.88	.81	1.00	4½	.93	.98	.78	.74	.67	1.00
238	0.98	1.00	0.93	.91	.83	1.00	4¾	.90	.96	.75	.71	.63	1.00
250	0.99	1.00	0.95	.93	.86	1.00	5	.88	.94	.70	.65	.57	1.00
263	0.99	1.00	0.96	.94	.87	1.00	5½	.85	.91	.65	.60	.52	.99
275	1.00	1.00	0.98	.96	.89	1.00	6	.83	.88	.60	.54	.46	.98
288	1.00	1.00	0.98	.97	.91	1.00	6½	.78	.83	.55	.47	.40	.97
300	1.00	1.00	0.99	.98	.93	1.00	7	.75	.78	.50	.41	.35	.94
313	1.00	1.00	0.99	.99	.94	1.00	8	.70	.71	.44	.36	.31	.91
325	1.00	1.00	1.00	1.00	.95	1.00	9	.60	.63	.38	.30	.27	.85
338	1.00	1.00	1.00	1.00	.96	1.00	10	.50	.52	.29	.25	.23	.78
350	1.00	1.00	1.00	1.00	.98	1.00	11	.40	.40	.20	.20	.20	.65
>350	1.00	1.00	1.00	1.00		1.00	>11	.40	.40	.20	.20	.20	.65

*Both factors should not be used; apply only the factor which gives the minimum capacity.

(4) *Moisture and temperature* (table 3-5). Moisture and temperature affect the capacity of road surfaces. The type of soil upon which the roadway is constructed becomes increasingly important as surface rigidity decreases. Heavy concentrations of, or long exposures to, moisture affect the subsoil of even the highest type of pavement, while both the surface and the subsoil of low type or unimproved roads are immediately affected. The degree of moisture can be determined by

studying data on soil conditions and on seasonal weather variations. Tables 3-5 and 3-7 are guides for determining the effects of moisture and temperature on the capacity of a highway to withstand sustained and maximum vehicular movement. Reports of good, fair, and poor surface conditions must be evaluated by the analyst, who should compare them with other reports, photographs, and information about the road network.

Table 3-5. Factors Used to Determine Effect of Moisture and Temperature on Highway Capacity

Surface type	Vehicle type (highway ton- nage rating)	Type and condition of subsoil ¹										Silt ²				
		Sand and/or gravel					Clay									
		Dry	Moist	Wet	Frozen	Freeze & thaw	Dry	Moist	Wet	Frozen	Freeze & thaw	Dry	Moist	Wet	Frozen	Freeze & thaw
Cement concrete, bituminous concrete.	3T trk (avg for 2-axle)	1.00	1.00	0.95	1.00	0.95	1.00	1.00	0.80	1.00	0.75	---	---	---	---	---
	5T trk	1.00	1.00	0.95	1.00	0.95	1.00	1.00	0.80	1.00	0.75	---	---	---	---	---
	10T trk or stlr	0.90	0.90	0.90	1.00	0.90	0.90	0.90	0.80	1.00	0.75	---	---	---	---	---
	18T stlr	0.90	0.90	0.90	1.00	0.90	0.90	0.90	0.70	1.00	0.65	---	---	---	---	---
	50T stlr	0.90	0.90	0.85	1.00	0.80	0.90	0.90	0.70	1.00	0.65	---	---	---	---	---
	Admin veh	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	1.00	0.90	---	---	---	---	---
Intermediate bi- tuminous.	3T trk (avg for 2-axle)	0.90	0.90	0.80	1.00	0.80	0.90	0.90	0.55	1.00	0.50	---	---	---	---	---
	5T trk	0.90	0.90	0.80	1.00	0.80	0.90	0.90	0.55	1.00	0.50	---	---	---	---	---
	10T trk or stlr	0.80	0.80	0.70	1.00	0.70	0.80	0.80	0.45	1.00	0.40	---	---	---	---	---
	18T stlr	0.80	0.80	0.70	1.00	0.70	0.80	0.80	0.45	1.00	0.40	---	---	---	---	---
	50T stlr	0.80	0.80	0.60	1.00	0.60	0.80	0.80	0.45	1.00	0.40	---	---	---	---	---
	Admin veh	1.00	1.00	0.90	1.00	1.90	1.00	1.00	0.65	1.00	0.65	---	---	---	---	---
Bituminous surface treatment.	3T trk (avg for 2-axle)	0.60	0.70	0.30	1.00	0.30	0.60	0.70	0.20	1.00	0.10	0.40	0.40	0	1.00	0
	5T trk	0.40	0.50	0.30	1.00	0.30	0.40	0.50	0.20	1.00	0.12	0.25	0.25	0	1.00	0
	10T trk or stlr	0.30	0.35	0.20	1.00	0.20	0.30	0.35	0.10	1.00	0.025	0.15	0.15	0	1.00	0
	18T stlr	0.25	0.30	0.15	1.00	0.15	0.25	0.30	0.07	1.00	0.025	0.10	0.10	0	1.00	0
	50T stlr	0.25	0.30	0.15	1.00	0.15	0.25	0.30	0.07	1.00	0.025	0.10	0.10	0	1.00	0
	Admin veh	0.80	0.80	0.60	1.00	0.60	0.80	0.80	0.45	1.00	0.25	0.50	0.50	0	1.00	0
Waterbound macadam, gravel, crushed stone.	3T trk (avg for 2-axle)	0.25	0.35	0.15	0.35	0.10	0.25	0.45	0.10	1.00	0.025	0.15	0.15	0	1.00	0
	5T trk	0.25	0.35	0.15	0.35	0.10	0.25	0.45	0.12	1.00	0.07	0.15	0.15	0	1.00	0
	10T trk or stlr	0.20	0.30	0.10	0.30	0.05	0.20	0.30	0.025	1.00	0	0.10	0.10	0	1.00	0
	18T stlr	0.10	0.25	0.05	0.25	0.05	0.10	0.25	0.025	1.00	0	0.05	0.05	0	1.00	0
	50T stlr	0.10	0.25	0.05	0.25	0.05	0.10	0.25	0.025	1.00	0	0.05	0.05	0	1.00	0
	Admin veh	0.40	0.50	0.30	0.50	0.15	0.40	0.55	0.25	1.00	0.15	0.30	0.30	0	1.00	0
Improved earth.	3T trk (avg for 2-axle)	0.15	0.35	0.10	0.35	0.15	0.30	0.65	0	1.00	0	0.05	0.05	0	1.00	0
	5T trk	0.17	0.35	0.12	0.35	0.17	0.30	0.65	0	1.00	0	0.05	0.05	0	1.00	0
	10T trk or stlr	0.17	0.30	0.05	0.30	0.10	0.17	0.40	0	1.00	0	0	0	0	1.00	0
	18T stlr	0.05	0.30	0.025	0.25	0.05	0.17	0.40	0	1.00	0	0	0	0	1.00	0
	50T stlr	0.05	0.25	0.025	0.25	0.05	0.17	0.40	0	1.00	0	0	0	0	1.00	0
	Admin veh	0.25	0.50	0.20	0.50	0.25	0.55	1.00	0	1.00	0	0.15	0.15	0	1.00	0
Unimproved earth.	3T trk (avg for 2-axle)	0.15	0.25	0.07	0.25	0.07	0.30	0.55	0	2.00	0	0.05	0.05	0	2.00	0
	5T trk	0.17	0.25	0.07	0.25	0.07	0.30	0.55	0	2.00	0	0.05	0.05	0	2.00	0

10T trk or stlr -----	0.10	0.20	0.025	0.20	0.025	0.17	0.30	0	2.00	0	0	0	0	2.00	0
18T stlr -----	0.05	0.20	0	0.20	0	0.17	0.30	0	2.00	0	0	0	0	2.00	0
50T stlr -----	0.05	0.20	0	0.20	0	0.17	0.30	0	2.00	0	0	0	0	2.00	0
Admin veh -----	0.25	0.40	0.12	0.40	0.10	0.55	0.80	0	2.00	0	0.15	0.15	0	2.00	0

¹ Factors are based upon the assumption that the road has been properly constructed, and thickness of base is adequate.

² This type of subsoil normally is not found under high-type pavements; consequently, factors are not shown. However, where high-type pavements have been constructed over silt subsoil in northern areas, capacities are reduced during certain times of the year due to subsoil weakening. The extent of reduction will depend upon the judgment of the analyst.

Table 3-6. Base Thickness Factors (Temperate Zones)

Surface type	Base thickness (inches)*									
	1	2	3	4	5	6	7	8	9	10
Cement concrete, bituminous concrete -----	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Block type surface -----	0.13	0.26	0.38	0.49	0.62	0.75	0.88	1.0		
Intermediate bituminous, bituminous surface treated -----	0.2	0.35	0.5	0.65	0.83	1.0				
Waterbound macadam, gravel, crushed stone (total thickness)	0.3	0.52	0.79	1.0						

*Interpolation should be used to obtain factor if fractions of an inch are encountered.

(5) Number of traffic lanes.

(a) *One lane.* Since roads less than 18 feet wide should be used for one-way movement only, the whole adjusted sustained capacity is in one direction. If a one-way movement is to be maintained over a period of time, some provision must be made for the return of empty trucks, either by alternate routes or by a reduction in the hours of forward operation. The one-way factors shown in table 3-2 consider one forward lane only, although a 17-foot road with good shoulders also has limited usefulness for return of empties.

(b) *Two lanes.* Roads over 18 feet in width can support one-way or two-way movement. Since the capacities shown in table 3-1 are for all traffic, the adjusted capacity will be in terms of total traffic moving in both directions for two-way movement. Therefore, half of this total two-way movement represents the highway capacity in one direction.

(c) *Multilane.* A multilane, divided highway of a given width can support a greater volume of traffic than can an undivided highway of the same width because all traffic on any one lane is moving in the same direction. Since total traffic may move in one or both directions, the adjusted capacity may be determined in the manner described in (b) above. The greater inherent capacities of multilane systems are allowed for in table 3-2.

(6) Operational factors.

(a) *Turning and cross movements.* Although the turning and cross movements factors vary between 1.0 and 0.5, depending on the size and nature of the overall operation, the average factor of 0.85 may be used when estimating highway capacity.

(b) *Hours of running time.* Running time usually is determined by the hours of daylight or darkness. In no case should the running time for sustained movement be more than 18 hours a day. When a one-way movement is planned over a route with no alternate, the running time selected must include time for returning empties and for turning around.

(c) *Weather and other factors.* Certain operational factors such as the weather, tactical situation, and movements of unknown vehicles, cannot be accurately assessed beforehand.

(7) *Base thickness.* Factors applicable to base thickness may be required. For the transportation planner, normally this is not necessary, since the thickness of base in road construction is usually adequate. Should the base not be adequate, thereby producing a factor other than unity, the quantities in table 3-6 can be used.

e. Making the Estimate.

(1) *General.* Since conditions dictate the factors which must be used when estimating a highway's capacity, the analyst must consider each problem separately. In some situations, a factor of 1.0 will apply; in such cases, the highway capacity is not affected. Methods and examples of estimating highway capacity to support normal and maximum movements are given below.

(2) Methods.

(a) *Normal movement.* To estimate sustained highway capability, determine surface type and multiply the operational capacity in number of trucks (table 3-1) successively by each of the following factors that is applicable: width of surface and shoulder,

Table 3-7. Number of Days Surfaces Can Support a Maximum Movement without Road Maintenance

Surface type	Vehicle type (highway tonnage ratings)	Type and condition of subsoil ¹											
		Sand and/or gravel				Clay				Silt ²			
		Dry	Moist	Wet	Freeze & thaw	Dry	Moist	Wet	Freeze & thaw	Dry	Moist	Wet	Freeze & thaw
Cement concrete, bituminous concrete.	3T trk (avg for 2-axle) --	30	30	20	20	30	30	10	10	-----	-----	-----	-----
	5T trk -----	30	30	20	20	30	30	10	10	-----	-----	-----	-----
	10T trk or stlr -----	30	30	20	20	30	30	10	10	-----	-----	-----	-----
	18T stlr -----	30	30	20	20	30	30	10	10	-----	-----	-----	-----
	50T stlr -----	30	30	20	20	30	30	10	10	-----	-----	-----	-----
	Admin veh -----	90	90	50	50	90	90	50	50	-----	-----	-----	-----
Intermediate bituminous.	3T trk (avg for 2-axle) --	15	15	5	5	15	15	2	2	-----	-----	-----	-----
	5T trk -----	15	15	5	5	15	15	2	2	-----	-----	-----	-----
	10T trk or stlr -----	15	15	5	5	15	15	2	2	-----	-----	-----	-----
	18T stlr -----	15	15	5	5	15	15	2	2	-----	-----	-----	-----
	50T stlr -----	15	15	5	5	15	15	2	2	-----	-----	-----	-----
	Admin veh -----	50	50	20	20	50	50	10	10	-----	-----	-----	-----
Bituminous surface treatment.	3T trk (avg for 2-axle) --	10	10	3	3	10	10	1	1	2	2	0.50	0.50
	5T trk -----	10	10	3	3	10	10	1	1	2	2	0.50	0.50
	10T trk or stlr -----	10	10	3	3	10	10	0.75	0.75	2	2	0.25	0.25
	18T stlr -----	10	10	3	3	10	10	0.75	0.75	2	2	0.25	0.25
	50T stlr -----	10	10	3	3	10	10	0.75	0.75	2	2	0.25	0.25
	Admin veh -----	20	20	10	10	20	20	10	10	5	5	2	2
Waterbound macadam, gravel, crushed stone.	3T trk (avg for 2-axle) --	5	5	1	1	5	5	0.62	0.62	0.50	0.50	<0.25	<0.25
	5T trk -----	5	5	1	1	5	5	0.62	0.62	0.50	0.50	<0.25	<0.25
	10T trk or stlr -----	5	5	0.5	0.5	5	5	0.37	0.37	0.50	0.50	<0.25	<0.25
	18T stlr -----	5	5	0.5	0.5	5	5	0.37	0.37	0.50	0.50	<0.25	<0.25
	50T stlr -----	--	--	-----	-----	5	5	0.37	0.37	0.50	0.50	<0.25	<0.25
	Admin veh -----	10	10	2	2	10	10	1.5	1.5	1	1	<0.25	<0.25
Improved earth -----	3T trk (avg for 2-axle) --	5	5	<0.25	<0.25	5	5	<0.25	<0.25	0.25	0.25	<0.25	<0.25
	5T trk -----	5	5	<0.25	<0.25	5	5	<0.25	<0.25	0.25	0.25	<0.25	<0.25
	10T trk or stlr -----	5	5	<0.25	<0.25	5	5	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	18T stlr -----	5	5	<0.25	<0.25	5	5	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	50T stlr -----	--	--	-----	-----	5	5	<0.25	<0.25	0.25	0.25	<0.25	<0.25
	Admin veh -----	10	10	<0.25	<0.25	10	10	10	10	0.25	0.25	<0.25	<0.25
Unimproved earth ----	3T trk (avg for 2-axle) --	5	5	<0.25	<0.25	5	5	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	5T trk -----	5	5	<0.25	<0.25	5	5	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	10T trk or stlr -----	5	5	<0.25	<0.25	5	5	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	18T stlr -----	5	5	<0.25	<0.25	5	5	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	50T stlr -----	--	--	-----	-----	5	5	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Admin veh -----	10	10	<0.25	<0.25	10	10	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25

¹ Under frozen conditions, a maximum movement can be supported for the duration of the freeze.

² See note 2, table 3-5.

curve and gradient, moisture and temperature, base thickness, and operational factors. The product is for a 24-hour day. It should then be adjusted in one of two ways as follows:

1. Adjust the figure to reflect the actual working hours in the day by multiplying it by the following fraction:

$$\frac{\text{Working hours in day}}{24}$$

2. If making a strategic estimate for which definite information as to method of operation is not known, the figure should be adjusted to reflect daylight hours only by multiplying it by the following fraction:

$$\frac{\text{Daylight hours in day}}{24}$$

Adjust the figure further to show movement in one direction only by dividing by 2 if movement is two-way. If movement is one-way, no further reduction is necessary since the all-traffic capacity represents loaded movement in one direction. Convert to tonnage capability.

(b) *Maximum movement.* To estimate the capability of a highway to support a maximum movement with no road maintenance, multiply the basic daily capacity successively by the surface and shoulder width factors, the curve and gradient factor, the turning and cross movement factor, and the base thickness factor, if applicable. The other factors are not used as multipliers in making a maximum estimate, since this type of operation calls for maximum tonnage within a short time, with no requirement for sustained movement. Adjustments of the figure thus obtained are made in the same manner as for the normal movement described in (a) above, except that the working day is 20 hours. Owing to the influence of the surface on such movements when no road maintenance is performed, high type surfaces can sustain movements for longer periods than low type surfaces (table 3-7).

(c) *Highway capability checklist.* In order to eliminate or reduce the possibility of omitting important considerations when estimating highway capability, the following checklist may be used as a guide.

(a) *Technical planning information.*

1. Point-to-point distance.
2. Surface type and width.
3. Vehicle type and average load.
4. Shoulder type and width.
5. Base type and thickness.
6. Alinement (curvature and gradient).
7. Subsoil type and condition.
8. Traffic and bridge data.

(b) *Planning guide factors.*

1. Operational or basic capacity (vehicles per day).
2. Surface and shoulder width.
3. Curve and gradient.
4. Pavement deterioration (moisture and temperature).
5. Base thickness.
6. Operational factors.

(c) *Planning estimate.*

1. Practical daily capacity (vehicles per day).
2. Capability (short tons per day).

(4) *Examples.* (Slide-rule calculations are sufficiently accurate for these estimates.)

(a) *Bituminous-surface treatment.*

1. *Problem.* What is the sustained capability of a bituminous-surface treated highway where—

Surface is 12 to 20 feet wide and has clay subsoil.

Shoulder width is 6 to 7 feet.

Ruling gradient is 10 percent.

Minimum curve radius is 100 feet.

It is the dry season.

Alternate routes are available for the return of empty trucks.

Operations are 12 hours per day.

Cargo trucks averaging 3 tons are used.

2. *Solution.* The operational capacity for 3-ton cargo vehicles on bituminous-surface treatment is 16,900 vehicles per day (table 3-1). Inasmuch as surface widths vary from 12 to 20 feet, the estimate must be for a one-way movement. The returning empty trucks will use alternate routes. The surface width factor (table 3-2) is 0.68 for a 12-foot surface; the shoulder factor is 0.99. The curve and

gradient factor for 10-percent grades is 0.5 (table 3-4). The moisture factor is 0.6 for bituminous-surface treatment in dry weather with clay subsoil (table 3-5). The average factor for turning and cross movement is 0.85. Therefore, the calculation for this estimate is $16,900 \times 0.68 \times 0.99 \times 0.5 \times 0.6 \times 0.85$, or 2,910 vehicles per day. Multiplying the number of vehicles by 3 (the average payload in short tons carried by each vehicle) gives a highway capability of 8,730 short tons per 24-hour day for a sustained period. Since the operation is only for 12 hours per day, the net capability is half of 8,370, or 4,365 short tons per day. It should be noted that this problem involves a 12-hour, one direction movement because alternate routes are available for the returning empties. Had no alternate routes been available, the running time, which must include time for changing direction and returning empties, might have been 8 hours forward, 8 hours returning, and 2 hours for transition. This makes a total of 18 hours per day, which is the recommended maximum for sustained movement.

(b) *Gravel surface.*

1. *Problem.* What is the sustained capability of gravel surfaced road where—

Surface is 18 feet wide with a clay base.

Shoulder width is 2 feet.

Ruling gradient is 10 percent.

Minimum curve radius is 200 feet.

It is the wet season.

No alternate routes are available.

Operations are 14 hours per day.

Three-ton cargo trucks are used.

2. *Solution.* The operational capacity of a gravel surface to support 3-ton cargo trucks is 6,700 vehicles per day (table 3-1). A two-way movement is planned because the surface is 18 feet wide and no alternate routes are available. According to table 3-2, the surface-width factor is 0.75; the shoulder-width factor is 0.8. The curve and gradient factor is 0.5 (table 3-4). Table 3-5 shows the moisture factor to be 0.10 for a wet gravel road with clay subsoil. The factor of 0.85 is used for turning and cross movement. The calculation

for this estimate is $6,700 \times 0.75 \times 0.8 \times 0.5 \times 0.10 \times 0.85$, or 171 vehicles per day with vehicles traveling in both directions. Therefore, 171 divided by 2 will give 85 vehicles for a one-direction movement. Then 85×3 (average number of tons carried by each vehicle) equals a capability of 255 short tons per 24-hour day. Using a 14-hour working day, the net capability is 14×255 , or 149 short tons per day

for sustained operations.

(c) *Four-lane, divided highway.*

1. *Problem.* What is the sustained capability of a four-lane, divided highway where—

Surface is cement concrete with clay subsoil.

Width of each two-lane section is 24 feet.

Shoulders are 8 feet wide.

Ruling gradient is 4 percent.

Minimum curve radius is 1,000 feet.

The weather is dry.

Operations are 12 hours per day.

Three-ton cargo trucks are used.

2. *Solution.* Use the operational capacity of 16,900 vehicles per day for a cement concrete surface as the basic figure for the computation (table 3-1). The surface width factor for a 4-lane, divided highway with two 24-foot surfaces is 2.5 and the shoulder width factor is 1.0 (table 3-2). The curve and gradient factor (table 3-4) is 0.95 for 4-percent grades. The moisture factor for cement concrete with clay subsoil in dry condition is 1.0 (table 3-5). The average factor for turning and cross movement is 0.85. Thus, the calculation for sustained movements on this section of highway is— $16,900 \times 2.5 \times 1.0 \times 0.95 \times 1.0 \times 0.85$, or 34,117 vehicles. This figure represents the number of vehicles per 24-hour day that is the practical total capacity of the highway. Since returning empty trucks will use the highway also, the cargo movement forward will be one-half of the capacity. Therefore, the traffic in one direction will be 17,050 vehicles per day. Because operations are for only 12 hours per day, 17,050 must be divided by 2 which

gives a net capacity in one direction of 8,525 vehicles per day. The sustained capability in tonnage will be $8,525 \times 3$, or 25,575 short tons per day.

(d) *Maximum movement over four-lane, divided highway.*

1. *Problem.* What is the maximum movement capability of the four-lane, divided highway described in (c) above?

2. *Solution.* Procedure is the same as that outlined in (c) above, except that basic capacity is used instead of operational capacity (table 3-1), the moisture factor is not considered, and running time is increased to 20 hours per day. The computation is $21,100 \times 2.5 \times 1.0 \times 0.95 \times 0.85$, or 42,600 vehicles per 24-hour day traveling in both directions. Since operations are for 20 hours per day and only forward traffic is desired, $42,600 \times 20/24 \div 2$ would give 17,700 vehicles per day forward. The net short term tonnage capability is then

$17,700 \times 3$, or 53,100 short tons per day. This capability for cement concrete is dry weather could be maintained on a maximum basis for 30 days (table 3-7), giving a total projected capability on a maximum or "crash" basis of 1,593,000 short tons.

f. *Making the Estimate with Limited Information.* Table 3-8 may be used as a guide in the absence of more accurate data for estimating the supply support tonnage capabilities of highways under varied conditions, assuming operations are sustained, adequate road maintenance is provided, and each road bears two-way traffic. In using the "Reductions" portion of table 3-8, multiply the daily forward tonnage successively by each of the three factors that is applicable (narrow roadway, one of the next three concerning terrain, and seasonal bad weather). It should be noted that the seasonal bad weather factor applies only when the estimate is for a sustained period.

Table 3-8. Making the Estimate with Limited Information

Type of road	Daily tonnage forward (STON)			Reductions applicable to various conditions				
	Optimum dispatch route only	Supply traffic (COMMZ)	Supply traffic (combat zone)	Narrow roadway	Rolling terrain	Hilly with curves	Moun- tainous	Seasonal bad weather
Concrete -----	60,000	36,000	8,400	0.75	0.90	0.70	0.40	0.80
Bituminous -----	45,000	27,000	7,300	0.75	0.90	0.70	0.40	0.70
Bituminous treated -----	30,000	18,000	5,800	0.75	0.80	0.60	0.35	0.60
Gravel -----	10,150	6,090	3,400	0.75	0.80	0.50	0.30	0.40
Earth -----	4,900	2,940	1,600	0.75	0.75	0.40	0.20	0.10

Section IV. MAINTENANCE

3-41. Organization

Category	Definition	Scope	Performed by	Responsibility of
Organizational --	That maintenance normally authorized for, performed by, and the responsibility of a using unit on equipment in its possession. This maintenance consists of functions and repairs within the capabilities of authorized personnel skills, tools, and test equipment as prescribed in unit's TOE or TD. (Formerly known as 1st and	Care taken of, and maintenance performed on, equipment to keep it in a serviceable condition in accordance with applicable DA publications such as TM's, TB's, LO's, and ESC. These functions consist of: inspections, servicing, adjustments, lubrication, scheduled services, minor repairs, proper operation, records, and	Operator of crew, and organizational mechanics.	Unit commander.

<i>Category</i>	<i>Definition</i>	<i>Scope</i>	<i>Performed by</i>	<i>Responsibility of</i>
	2d echelon maintenance).	equipment serviceability criteria. All repair parts replacements and levels will be in accordance with PLL and levels as prescribed by TOE and TD.		
Direct support --	Maintenance normally authorized for, performed by, and the responsibility of designated maintenance activities. Direct support maintenance units provide support where feasible by on-site repair, replacement of assemblies and components, delivery of parts to the user, and technical assistance. Normally, TOE and TD of direct support organizations will specify this unit as having a maintenance mission and provide using units with on-site repairs. (Formerly known as 3d echelon maintenance).	Provide for replacement of major parts, components, assemblies, or end items. Arrange for the evacuation of unserviceable equipment from user to an activity where repairs can be accomplished, or to a collection or salvage facility. Assist in the performance of maintenance inspections of equipment and of organizational maintenance operations of the user to ascertain the condition of equipment and the effectiveness of organizational maintenance. Provides repair parts support, technical advice to units supported, maintenance float items, and inspection personnel.	Units having DSU responsibility (maintenance mission)	Army commander, division commander, installation commander.
General support --	Maintenance normally performed by semimobile units in support of the supply system or, when required, to support direct support units in the maintenance and repair for return to user.	Provide for the repair of end items and assemblies for return to the supply system or maintenance float. The performance of maintenance is accomplished through use of maintenance standards. This includes the overhaul and repair of end items and components for return to stock. Provide inspection personnel.	Units having GSU responsibility.	Army field commanders.
Depot -----	Maintenance normally performed by permanent installations using extensive equipment.	Provide for overhaul and repair of economically repairable materiel, augment the procurement program in satisfying overall Army requirements and, when required, provide for repair of materiel beyond the capability of general support maintenance organizations, and the maintenance of depot stocks in a ready-for-issue condition. When	Depot maintenance units.	Chief of Army Materiel Command.

<i>Category</i>	<i>Definition</i>	<i>Scope</i>	<i>Performed by</i>	<i>Responsibility of</i>
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required, will rebuild items to fulfill military assistance programs. This level required maintenance to be performed using manufacturers standards and/or maintenance standards established for this category.

3-42. Recommended Tire Pressures and Maximum Loads

The table below may be used as a guide for determining inflation pressures and maximum loads for tires. Pressures and loads shown are averages for the different makes of tires. If available, figures from the identification plate or technical manual for a particular vehicle should take precedence, if they differ from those listed below. To obtain better flotation (bearing surface) in soft sand, snow, or mud, tire pressure may be reduced, but pressure below 10 pounds per square inch is not recommended. In extreme cold, tire pressure should be increased 10 percent. Proper pressure should be restored as soon as practicable.

<i>Tire size</i>					<i>Tire size</i>				
<i>Passenger cars</i>	<i>Trucks, buses, and trailers</i>	<i>Number of plies</i>	<i>Recommended pressure (psi)</i>	<i>Recommended maximum load (lb)</i>	<i>Passenger cars</i>	<i>Trucks, buses, and trailers</i>	<i>Number of plies</i>	<i>Recommended pressure (psi)</i>	<i>Recommended maximum load (lb)</i>
5.50-16	-----	4	30	810	7.50-15	-----	8	55	1,780
5.90-15	-----	4	24	745	7.50-15	-----	10	80	3,310
*6.00-13	-----	4	27	750	7.50-15	-----	12	95	3,660
6.00-16	-----	4	28	915	7.50-16	-----	4	24	1,235
-----	6.00-16	6	45	1,140	7.50-16	-----	6	45	1,650
6.25-16	-----	4	28	985	7.50-16	-----	8	55	1,860
6.40-15	-----	4	24	830	7.50-17	-----	8	60	2,100
*6.50-13	-----	4	27	825	7.50-18	-----	8	60	2,200
6.50-16	-----	4	28	1,050	7.50-20	-----	8	60	2,375
-----	6.50-16	6	45	1,290	7.60-15	-----	4	26	1,090
-----	6.50-20	6	50	1,700	*8.00-14	-----	4	24	1,175
-----	6.50-20	8	65	1,950	8.00-15	-----	4	26	1,395
6.70-15	-----	4	26	910	8.00-22	-----	8	65	2,740
*6.95-14	-----	4	28	900	8.20-15	-----	4	24	1,415
*7.00-13	-----	4	27	925	-----	8.25-15	14	100	4,450
*7.00-14	-----	4	30	1,075	8.25-16	-----	6	34	1,690
-----	7.50-15	6	45	1,380	-----	8.25-20	10	65	2,900
-----	7.50-15	8	55	1,555	*8.50-14	-----	4	24	1,265
7.00-16	-----	4	26	1,145	*9.00-14	-----	4	24	1,355
-----	7.00-16	6	45	1,440	-----	9.00-15	12	75	4,510
-----	7.00-20	8	55	2,000	-----	9.00-16	8	45	2,250
-----	7.00-22	6	50	1,870	-----	9.00-20	8	45	2,775
7.10-15	-----	4	26	990	-----	9.00-20	10	65	3,250
*7.50-14	-----	4	24	1,085	-----	9.00-22	10	70	3,330
					-----	9.00-22	12	85	3,730
					*9.50-14	-----	4	24	1,465
					-----	9.75-20	12	70	3,900
					-----	9.75-22	12	70	4,200
					-----	9.75-24	12	70	4,400
					-----	10.00-15	14	85	5,480
					-----	10.00-20	12	70	4,000
					-----	10.00-22	10	70	3,960
					-----	10.00-22	12	70	4,275
					-----	10.00-24	12	70	4,550
					-----	10.50-20	12	75	4,700
					-----	10.50-22	12	75	5,000
					-----	10.50-24	12	75	5,200
					-----	11.00-20	12	70	4,500
					-----	11.00-22	12	70	4,750
					-----	11.25-20	14	80	5,450
					-----	11.25-24	14	80	6,050
					-----	12.00-20	14	75	5,275
					-----	12.00-22	12	75	5,150

For explanation of footnote see end of chart.

<i>Tire size</i>				
<i>Passenger cars</i>	<i>Trucks, buses, and trailers</i>	<i>Number of plies</i>	<i>Recommended pressure (psi)</i>	<i>Recommended maximum load (lb)</i>
-----	12.00-24	14	75	5,925
-----	12.75-20	16	90	7,200
-----	12.75-24	16	90	8,000
-----	13.50-20	16	95	8,200
-----	13.50-24	16	95	9,100
-----	14.00-20	12	45	5,450
-----	14.00-24	20	90	9,150
-----	16.00-25	20	60	9,475
-----	18.00-24	16	40	13,590

*Tubeless tires.

3-43. Vehicle and Motor Checklist

a. General.

(1) Is the general appearance of the motor pool satisfactory? -----

(2) Are "no smoking" signs posted in fuel dispensing areas? -----

(3) Is fuel dispensing area equipped with fire extinguishers of proper type and are they accessible? -----

(4) Are fuel dispensing personnel familiar with the operation of fire extinguishers? -----

(5) Have fire extinguishers been inspected at prescribed intervals? -----

(6) Are speed limits posted? -----

(7) Are parking areas designated? -----

(8) Is a traffic plan designated? -----

(9) Are vehicles checked for proper dispatch before departing from motor pool? -----

(10) Are covered metal containers provided for oily rags? -----

(11) Are containers available for the disposal of waste oil and solvents? -----

(12) Are containers available for ordinary waste? -----

(13) Are separate facilities available for the storage of paint and flammables; are "no smoking" signs posted? -----

b. Maintenance Shop and Records.

(1) Are tools and equipment properly

cleaned, serviced, and secured when not in use? -----

(2) Are regulations enforced regarding flammable materials? -----

(3) Are all preventive maintenance inspections properly supervised? -----

(4) Are equipment lubrication orders on hand and in use? -----

(5) Are appropriate technical manuals and bulletins on hand and readily available? -----

(6) Are technical manuals used in the performance of preventive maintenance inspections and services? -----

(7) Are adequate road tests performed on each vehicle as a part of preventive maintenance and inspection services? -----

(8) During scheduled preventive maintenance inspections, does the unit diagnose deficiencies correctly and initiate proper corrective action? -----

(9) Are vehicles requiring maintenance beyond the capability of unit promptly evacuated to a support maintenance facility? -----

(10) Are authorized tools on hand and in a serviceable condition? -----

(11) Are unserviceable tools turned in? -----

(12) Are air compressors and auxiliary engines properly serviced and maintained? -----

(13) Are lubricants properly stored, identified, and secured from contamination? -----

(14) Are repair parts utilized discriminately as substantiated by the condition of parts which have been replaced? -----

(15) Is welding, cutting, and grinding equipment properly maintained? -----

(16) Are protective goggles worn by personnel when operating welding, cutting, and grinding equipment? -----

(17) Is training of maintenance personnel adequate? -----

(18) Are all vehicles, auxiliary engines, and trailers entered on the roster? -----

(19) Are all vehicles scheduled for preventive maintenance services indicated by U.S. Army registration number? -----

(20) Are all entries for scheduled services made in pencil on advance basis and inked over when preventive maintenance service is completed? -----

(21) Are the proper symbols or letters used in posting the preventive maintenance roster? -----

(22) Are the preventive maintenance services properly distributed throughout the month? -----

(23) Are all forms on hand or on requisition that are needed to properly implement the Army system of maintenance? -----

(24) Are vehicle and equipment operational records properly filled out? -----

(25) Is the proper form used for preventive maintenance checks and services? Are these forms retained for the required period? -----

(26) Are all vehicles dispatched entered on the organizational control record for equipment? Are appropriate entries made in each column of the record? -----

(27) Do all drivers have the required U.S. Government motor vehicle operator's identification card? Are these cards properly made out? -----

(28) Is there an equipment logbook for each vehicle? -----

(29) Are all authorized publications on hand and available for ready reference? -----

(30) Are scheduled maintenance services being performed? -----

(31) Does the maintenance shop maintain an equipment modification record? -----

(32) Is the ordnance section of the organization and/or installation property book properly maintained and up to date? -----

(33) Do registration numbers of vehicles, serial numbers of other major items, and quantities of all major items on hand agree with those in organizational property book? -----

(34) Do quantities of major items shown as authorized in organizational property book agree with appropriate TOE, TA, or other competent authorizations? -----

(35) Are invalidated property issue slips maintained in a suspense file until validated copies are received from issuing agency? -----

(36) Are exchange tags used for repair parts? -----

(37) Are repair parts on hand within authorized allowances? -----

(38) Is the interchangeability of repair parts employed where possible? -----

(39) Are repair parts properly stored, tagged, and preserved? -----

(40) Are used repair parts accounted for by major items registration or serial number? -----

(41) Are stock number changes posted to date in supply records and catalogs? -----

(42) Have parts required for inoperable equipment been requested? -----

(43) Is followup made on outstanding requests for repair parts? -----

(44) Are all required supply publications on hand? -----

(45) Is strict supply economy practiced in the use of repair parts and supplies? -----

(46) Are supply personnel adequately trained in use of supply publication procedures? -----

(47) Are unserviceable recoverable parts and assemblies promptly returned to supporting unit? -----

(48) Is a jacket file of hand receipts maintained for property loaned to another unit, organization, activity, or individual? -----

c. Vehicle Inspection.

(1) Is the general appearance of the vehicle satisfactory? -----

(2) Are registration and unit markings in accordance with current directives? -----

(3) Are engine compartments clean? -----

- (4) Are cab compartments clean? -----
- (5) Is cargo space clean? -----
- (6) Is vehicle free of rust? -----
- (7) Are door glasses present, unbroken, and clean? -----
- (8) Do door glass regulators operate properly? -----
- (9) Do door latches operate properly? -----
- (10) Do lights operate properly? -----
- (11) Is condition of canvas, upholstery, and fastenings satisfactory? -----
- (12) Are footbrakes adjusted for proper free travel? -----
- (13) Are handbrakes adjusted properly? -----
- (14) Is battery electrolyte at proper level? -----
- (15) Is engine oil clean and at proper level? -----
- (16) Is cooling system filled to proper level? -----
- (17) Is there a copy of the operator's reporting form for a motor vehicle accident in each vehicle? -----
- (18) Is there an accident identification card in each vehicle? -----
- (19) Are all on-equipment materiel

OEM) tools present and in good condition?-----

(20) Does the driver seem adequately trained? -----

(21) Is the driver properly licensed? -----

(22) Is there a copy of the vehicle technical manual and lubrication order in each vehicle? -----

3-44. Safe Operating Distances Between Vehicles

The chart below shows average values which may be used in determining safe gaps between vehicles at various speeds on average hard-surfaced roads. Since well-trained drivers can reduce the distance traveled during the perception and reaction periods, the planner should consider the physical condition and state of training of drivers for a particular operation, keeping in mind that rain, snow, or ice presents special conditions. Braking distances are based on the assumption that the vehicles are loaded and have good brakes, tires, and traction. Total distances have been determined from the standpoint of safety only; the tactical situation may require larger or smaller gaps. In the absence of definite information, the following rule-of-thumb method may be used to determine the gap between vehicles in a convoy; speedometer reading (mph) $\times 2 =$ gap in yards, or speedometer reading (kmph) $\times 1.2 =$ gap in meters. (This method should be used only for speeds indicated by asterisks.)

Speed			Average distance required for stopping								Total ¹	
mph	kmph	ft/sec	Perception		Reaction		Braking				Yards	Meters
			Feet	Meters	Feet	Meters	Feet	Meters	Feet			
<i>Passenger vehicles ²</i>												
20*	32.2	29.3	22	6.7	22	6.7	25	7.6	69	23	21.0	
25*	40.3	36.7	28	8.5	28	8.5	35	10.7	91	30	27.7	
30*	48.3	44.0	33	10.0	33	10.0	48	14.6	114	38	34.6	
35*	56.3	51.3	39	11.9	39	11.9	67	20.4	145	48	44.2	
40*	64.4	58.7	44	13.4	44	13.4	90	27.4	178	59	54.2	
45*	72.4	66.0	50	15.3	50	15.3	117	35.7	217	73	66.3	
50*	80.5	73.4	55	16.8	55	16.8	148	45.2	258	86	78.8	
55	88.5	80.7	61	18.6	61	18.6	185	56.4	307	102	93.6	
60	96.6	88.0	66	20.1	66	20.1	228	69.6	360	120	109.8	
65	104.6	95.4	72	21.9	72	21.9	275	83.9	419	140	127.7	
70	112.6	102.7	77	23.5	77	23.5	332	102.5	486	162	149.5	

Speed			Average distance required for stopping								Total ¹ Yards	Meters
mph	kmph	ft/sec	Perception		Reaction		Braking		Feet			
			Feet	Meters	Feet	Meters	Feet	Meters				
Single-unit vehicles with gross weight less than 10,000 pounds												
20*	32.2	29.3	22	6.7	22	6.7	30	9.2	74	25	22.6	
25*	40.3	36.7	28	8.5	28	8.5	42	12.8	98	33	29.8	
30*	48.3	44.0	33	10.0	33	10.0	58	17.7	124	41	37.7	
35*	56.3	51.3	39	11.9	39	11.9	80	24.4	158	53	48.2	
40*	64.4	58.7	44	13.4	44	13.4	106	31.4	194	65	58.2	
45*	72.4	66.0	50	15.3	50	15.3	138	42.1	238	79	72.7	
50	80.5	73.4	55	16.8	55	16.8	177	54.0	287	96	87.6	
55	88.5	80.7	61	18.6	61	18.6	222	67.5	344	115	104.7	
60	96.6	88.0	66	20.1	66	20.1	273	83.3	405	135	123.5	

Single-unit, 2-axle vehicles with gross weight of 10,000 pounds or more

20*	32.2	29.3	22	6.7	22	6.7	40	12.2	84	28	25.6
25*	40.3	36.7	28	8.5	28	8.5	64	19.5	120	40	36.5
30	48.3	44.0	33	10.0	33	10.0	92	28.0	158	53	48.0
35	56.3	51.3	39	11.9	39	11.9	126	38.4	204	68	62.2
40	64.4	58.7	44	13.4	44	13.4	165	50.3	253	84	77.1
45	72.4	66.0	50	15.3	50	15.3	208	63.4	308	103	94.0
50	80.5	73.4	55	16.8	55	16.8	256	78.1	366	122	111.7
55	88.5	80.7	61	18.6	61	18.6	310	94.5	432	144	131.7
60	96.6	88.0	66	20.1	66	20.1	372	113.5	504	168	153.7

Single-unit vehicles with more than 2 axles and combination of vehicles (tractor truck, semitrailer, and trailer) with gross weight of 10,000 pounds or more

20*	32.2	29.3	22	6.7	22	6.7	50	15.3	94	32	28.7
25	40.3	36.7	28	8.5	28	8.5	80	24.4	136	45	41.4
30	48.3	44.0	33	10.0	33	10.0	115	35.1	181	60	55.1
35	56.3	51.3	39	11.9	39	11.9	157	47.9	235	78	71.7
40	64.4	58.7	44	13.4	44	13.4	205	62.5	293	98	89.3
45	72.4	66.0	50	15.3	50	15.3	260	79.3	360	120	109.9
50	80.5	73.4	55	16.8	55	16.8	320	97.6	430	143	131.2
55	88.5	80.7	61	18.6	61	18.6	388	118.3	510	170	155.5
60	96.6	88.0	66	20.1	66	20.1	465	141.9	597	199	182.1

¹ Add 30 feet, 10 yards, or 9 meters to each total stopping distance shown when determining actual gap to use between vehicles.

² Does not include buses. For this type of passenger-carrying vehicle, select figures from an applicable section in the remainder of the chart.

Section V. MISCELLANEOUS

3-45. Anchoring Methods (fig. 3-25)

a. Holdfasts. Natural anchorage should be used whenever possible. Sound wooden pickets, 3 inches in diameter and driven at least 3 feet into dry, undisturbed earth, should withstand the following pulls:

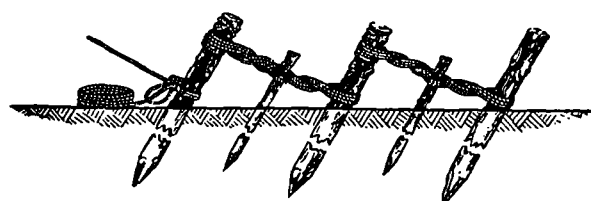
Picket	Pounds
Single	700
1-1 holdfast combination	1,400
1-1-1 holdfast combination	1,800
2-1 holdfast combination	2,000

Picket	Pounds
3-2-1 holdfast combination	4,000

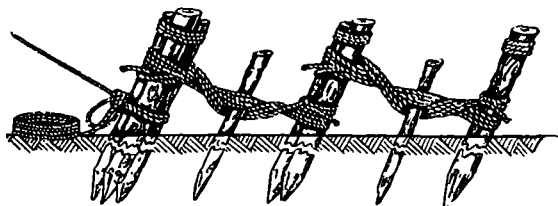
For wet earth, the holding power should be multiplied by the following factors:

Clay and gravel mixture	0.9
River clay or sand	0.5

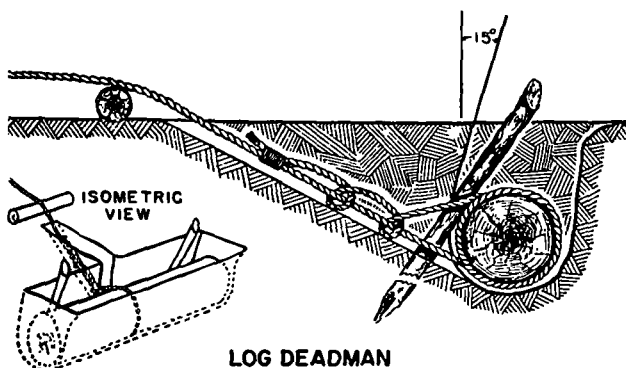
b. Deadman. The deadman is a log, railroad tie, or similar object sunk into the ground in such a manner as to afford anchorage for a line. The holding power of a deadman depends upon the bearing area and holding power of the earth. To determine the necessary bearing



PICKET HOLDFAST



3-2-1 COMBINATION PICKET HOLDFAST



LOG DEADMAN

Figure 3-25. Picket holdfast and deadman.

surface, divide the total stress by the values given in the chart below for the depth and cable inclination selected.

Mean depth of deadman in ordinary earth	Inclination of pull (vertical to horizontal) and safe resistance in pounds per square foot				
	Vertical	1 to 1	1 to 2	1 to 3	1 to 4
3 feet	600	950	1,300	1,450	1,500
4 feet	1,050	1,750	2,200	2,600	2,700
5 feet	1,700	2,800	3,600	4,000	4,100
6 feet	2,400	3,800	5,100	5,800	6,000
7 feet	3,200	5,100	7,000	8,000	8,400

c. *Installation of Deadman.* To obtain the best results when installing a deadman, the following procedure should be used?

(1) *Position.* The best position for the deadman is behind a natural crest or mound where as much surface of undisturbed earth

as possible may be used. It should be placed far enough away from the vehicle being winched or towed so that it will not interfere when the vehicle clears the obstacle. If the deadman is too close to the vehicle, an upward pull may cause the anchorage to become dislodged.

(2) *Digging.* Dig a trench deep enough to place the top of the deadman a foot or so below the ground surface, depending on the density of the soil, and long and wide enough to hold the deadman. Undercut the bank in the direction of pull at an angle of about 15° from the vertical. Clear the bottom of the hole at a right angle to this bank. To help strengthen the top edge of the hole in the direction of pull, drive two stakes on each side of the cable at a slightly greater angle to the vertical than the angle made by the bank and flush with the slanted bank near the top. Cut a trench for the cable from the hole through the crest of the hill or mound. This should be slightly deeper than the bottom of the hole at the beginning and should continue out in an ascending slope.

(3) *Cable attachment.* Attach the cable or chain so that the largest area of the deadman is against the forward bank, and so that any tendency of the deadman to rotate acts downward and not upward.

3-46. Improved, Unmounted A-Frame

An improvised A-frame (fig. 3-26) is a field expedient that provides both a lift and a tow. It is useful for lifting a vehicle out of or over a ditch or hole, and for recovering a badly mired heavy vehicle. It can be made with 2 poles, approximately 12 feet long, and chains, cables, or ropes. The chains are used for lashing the poles together and for towlines. The poles are locked together to form shears. The legs of the shears are placed in two holes that are dug about 6 inches deep and 6 feet apart; a line is strung across the top of the A-frame between the power source and the vehicle to be moved. The legs of the A-frame must be placed far enough away from the vehicle that is to be moved to keep them from damaging it when it is lifted up and forward. After the front wheels have been lifted out of the ditch,

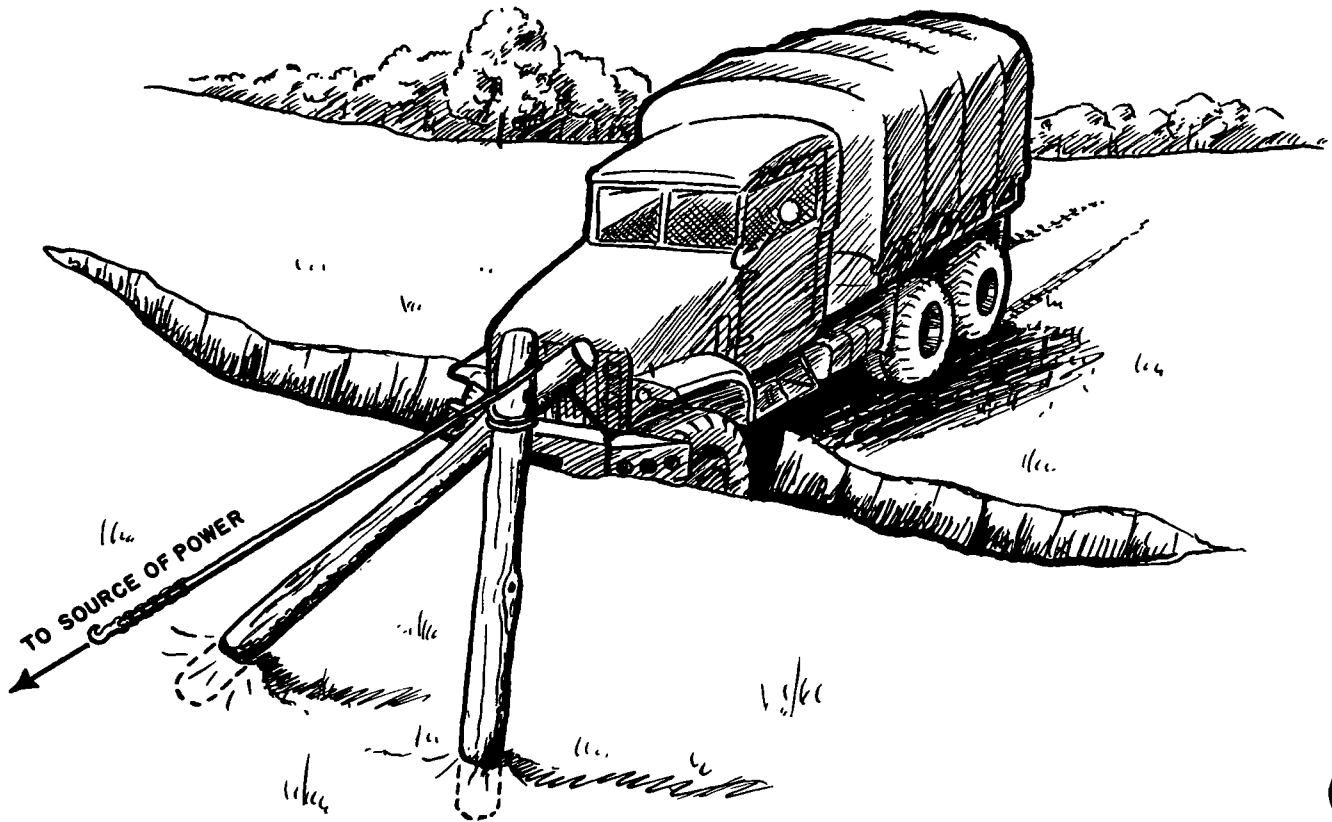


Figure 3-26. A-frame.

the vehicle must be moved slightly forward and the ditch filled or bridged to allow the rear wheels to cross.

3-47. Winch

a. Using the Winch.

(1) When used properly, the winch installed on Army vehicles furnishes great lifting and pulling power. Improper use or careless handling, however, results in inefficient performance and possible breakdown of the winch mechanism.

(2) A vehicle may be taken across an obstacle with the assistance of its own winch by attaching the winch cable to a deadman or tree. The power of the drive wheels should be used whenever possible to assist the winch. Transmission gears should be so selected that the speed of the vehicle's wheels as they move over the ground will be the same as that of the winch cable as it is wound on the winch drum.

(3) After the vehicle with winch has crossed an obstacle with the assistance of its own winch, it may be used to help other vehicles without winches over the obstacle by either straight towing or winching operations. The winch cable may be extended and attached to the other vehicle, the winch mechanism locked, and the truck used as a towing vehicle; or the winch truck may be halted and blocked, and the winch alone used.

(4) When pulling a vehicle with the winch of another, the towed vehicle should assist with its maximum traction. The best power combination generally results if the winch is operated in the highest gear that will give sufficient power and the truck being winched is pulling in lowest gear.

(5) When the winch is used on a difficult pull, the winch truck may be held in place by using the brakes and wheel blocks, or by anchoring to a tree or deadman. When the

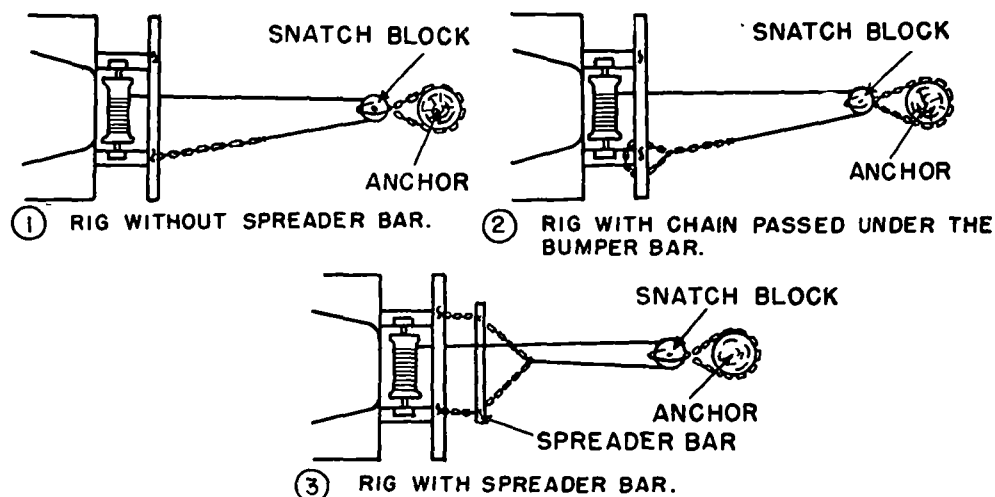


Figure 3-27. Use of winch and snatch block.

load is not too heavy, traction devices will assist in holding the vehicle in place. A snatch block may be used to increase the mechanical advantage of the winch when pulls are too heavy for the winch alone (fig. 3-27).

(6) Overturned vehicles cannot always be righted by manpower alone. When necessary, a rigging similar to that shown in figure 3-28 may be used. Parking brakes on the overturned vehicle should be applied before the vehicle is righted. Any towing or winching method may be used to pull on the rope. A holding bridle, placed opposite to the bridle shown in the figure, should be used to prevent the vehicle from being damaged by settling too rapidly. Also, to prevent damage to bridles and the body of the vehicle, padding (rags and/or small boards) should be used between points of contact.

b. Safety Precautions.

(1) Certain precautions are necessary in the proper use of the winch cable. Whenever the winch cable is slipped over abrasive surfaces (concrete, asphalt, etc.), it should be protected by placing pieces of wood under it. Power must be applied to the cable gradually. Kinks and twists must always be removed. Cables should not be tied in knots, except for emergency repair. They should not be rigged around an angle in such a manner as to bend

them. Vehicles with metal tires should not be permitted to run over the cable.

(2) Most winches have a shearpin which is designed to break off under any strain which might snap the cable. Nevertheless, when a steel cable is tightened, it may break and snap back with enough force to kill or seriously injure a man. Personnel should stand clear before the cable is tightened. Makeshift shearpins should not be used.

(3) The cable should be wound evenly on the drum when in use under load and when being rewound after use. To wind the cable evenly, at least a light load is necessary to prevent kinking. Otherwise, the cable may become tangled or damaged, resulting in sharp burrs which can cause serious injury.

(4) Personnel handling winch cables should always wear work gloves, preferably with leather palms, to protect themselves from cuts and scratches caused by broken strands in the cable.

3-48. Chespaling Mats: Expedient Surface for Muddy or Soft Areas

a. Chespaling mats (fig. 3-29) are useful in providing a temporary hard surface in soft sand, mud, or swampy areas. They may be made of small saplings or bamboo rods approximately 6 feet long and about 1½ inches

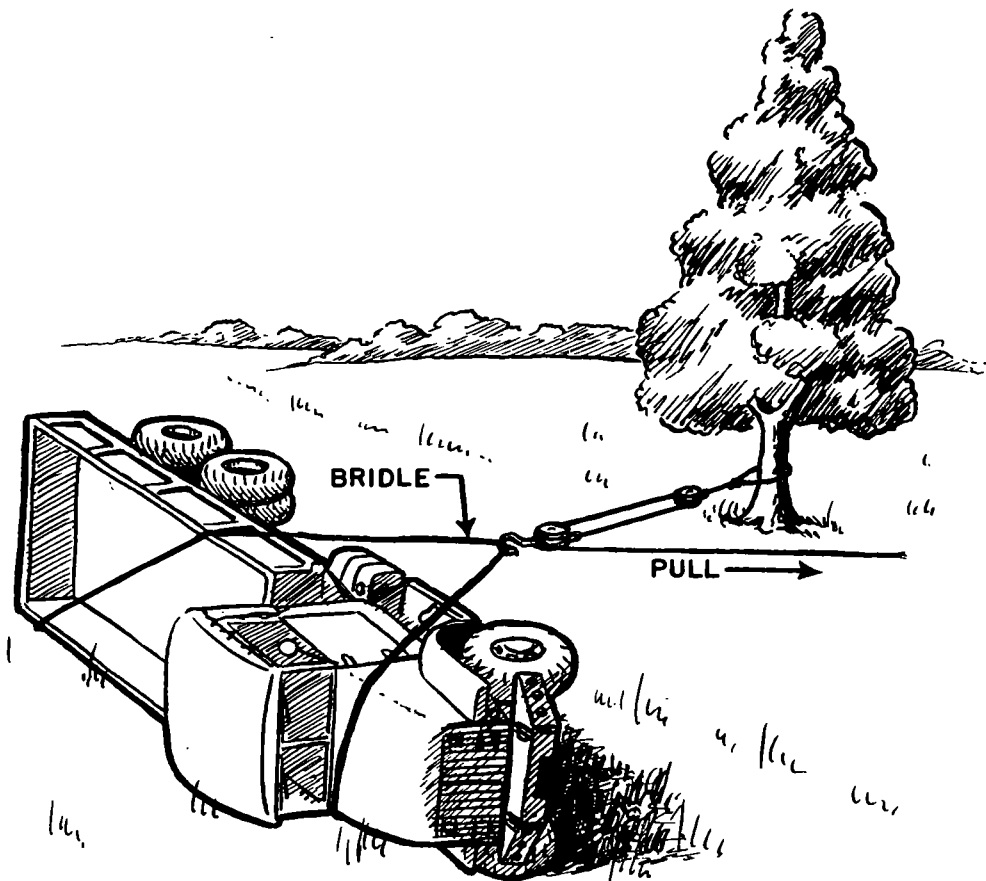


Figure 3-28. Using a winch to right an overturned vehicle.

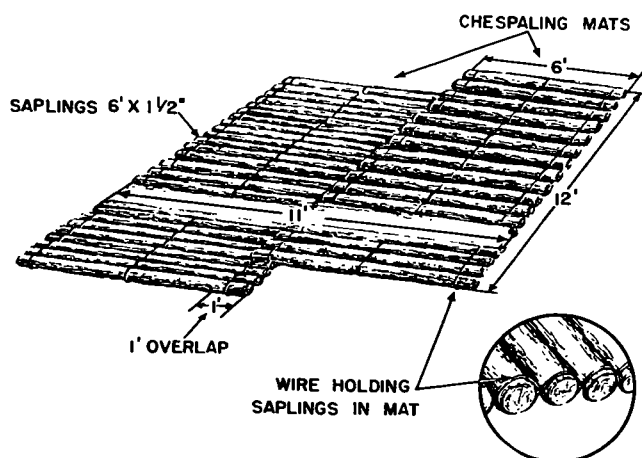


Figure 3-29. Chespalings mats.

in diameter. The saplings or rods are placed about 3 inches apart and wired together with the chicken-wire mesh or smooth wire strands. If saplings are used, they should be kept wet to preserve springiness in the wood and to prevent them from splitting or breaking. A 12-foot mat of this type weighs about 75 pounds.

b. To construct a chespaling road, two mats are laid lengthwise with a 1-foot overlap in the center. If more mats are added, 1-foot overlap is made on the ends. Pickets may be used to hold the mats down on curves. A mat road of this type should remain serviceable for 3 to 4 months, depending upon weather conditions and the condition of the surface over which it is laid. Approximately 1,500 vehicles may pass over such a road before replacement is needed.

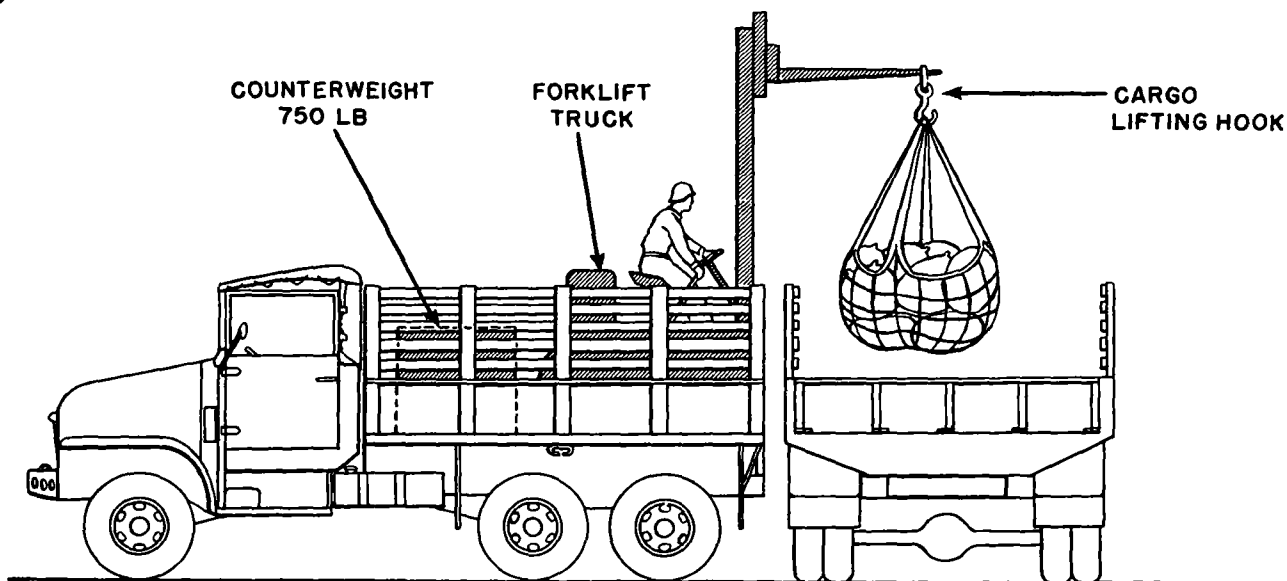


Figure 3-30. Forklift mounted on 6x6 truck.

a. Other type of expedient road surfaces for use in soft areas (swamp or snow) are shown in FM 31-70 and TM 5-337.

3-49. Truck-Mounted Forklift

The truck-mounted forklift is particularly suitable for transferring palletized cargo and fuel

drums. To mount the forklift truck, bolt it to the rear of the bed of a 6×6 truck (fig. 3.30). Place a counterweight of about 750 pounds at the forward end of the cargo floor. Remove the finger lift of the forklift truck and install an overhead 5-foot arm with a hook at its outer end.

3-50. Weights, Volume, and Conversion Factors for Packaged and Bulk Petroleum Products

Product	Packaging	Weight (lb)	Cubic ft		Conversion factors		Gallons per			Bbl. per MTON	Packages per			Capacity of vehicles for carrying filled containers ^a								
			Actual	Plan- ning factor	Gal. to lb	Lb to gal.	STON	LTON	MTON		STON	LTON	MTON	Trailer		Truck			Semitrailer			
														1- ton	1½- ton	1½- ton	2½- ton	Cargo 5-ton	10- ton	12- ton	25- ton	
Aviation gasoline	Bulk	---	---	---	5.90	.169	339	380	---	9.04												
	55-gal. drum ^a	373	9.03	11	6.91	.145	289	324	188	---	5.36	6	3.48	5	8	8	13	26	53	64	134	
	55-gal. drum ^b	389	8.8	11	7.20	.139	278	311	193	---	5.14	5.76	3.57	5	7	7	12	25	51	62	128	
	55-gal. drum ^c	364	9.2	11	6.90	.145	290	325	181	---	5.49	6.15	3.42	5	8	8	13	27	51	66	137	
	5-gal. can ^d	40.5	.81	1	8.0	.125	250	280	200	---	49.4	55.3	40.0	49	74	74	124	248	495	594	1,239	
91A gasoline	Bulk	---	---	---	6.11	.164	327	367	---	8.73												
	55-gal. drum ^a	384	9.03	11	7.11	.141	281	315	188	---	5.21	5.83	3.48	5	7	7	13	26	52	62	130	
	55-gal. drum ^b	400	8.8	11	7.41	.135	270	302	193	---	5.0	5.60	3.57	5	7	7	12	25	50	60	125	
	55-gal. drum ^c	376	9.2	11	7.09	.141	282	316	181	---	5.32	5.96	3.42	5	8	8	13	26	53	64	133	
	5-gal. can ^d	41.6	.81	1	8.32	.120	240	269	200	---	48.1	53.8	40.0	48	72	72	120	240	480	576	1,200	
Kerosene	Bulk	---	---	---	6.80	.147	294	329	---	7.84												
	55-gal. drum ^a	421	9.03	11	7.80	.128	256	287	188	---	4.75	5.32	3.48	4	7	7	12	23	47	57	119	
	55-gal. drum ^b	437	8.8	11	8.09	.124	247	277	193	---	4.58	5.13	3.57	4	6	6	11	22	46	55	114	
	55-gal. drum ^c	351	9.2	11	6.62	.151	302	338	181	---	5.70	6.38	3.42	5	8	8	14	28	57	68	142	
	5-gal. can ^d	45	.81	1	9.0	.111	222	249	200	---	44.4	49.8	40.0	44	66	66	111	222	445	534	1,110	
Diesel fuel	Bulk	---	---	---	6.99	.145	286	321	---	7.63												
	55-gal. drum ^a	432	9.03	11	8.0	.125	250	280	188	---	4.63	5.19	3.48	4	6	6	11	23	46	55	116	
	55-gal. drum ^b	448	8.8	11	8.30	.120	241	270	193	---	4.46	5.00	3.57	4	6	6	11	22	45	53	112	
	55-gal. drum ^c	430	9.2	11	8.11	.123	247	276	181	---	4.65	5.21	3.42	4	7	7	11	23	46	55	116	
	5-gal. can ^d	46	.81	1	9.20	.109	317	244	206	---	43.5	48.7	40.0	43	65	65	109	217	436	522	1,090	
Lubricating oils	Bulk	---	---	---	7.60	.132	263	295	---	7.02												
	55-gal. drum ^a	472	9.03	11	8.58	.117	233	261	191	---	4.24	4.75	3.48	4	6	6	10	21	42	51	106	
	55-gal. drum ^b	488	8.8	11	8.87	.113	226	253	196	---	4.10	4.59	3.57	4	6	6	10	20	41	49	102	
	55-gal. drum ^c	462	9.2	11	8.56	.117	234	262	185	---	4.33	4.85	3.42	4	6	6	10	21	43	52	108	
	5-gal. can ^d	49	0.81	1	9.80	.102	204	229	181	---	40.8	45.7	40.0	40	61	61	102	204	410	489	1,020	
	Case of 1-qt cans																					
	(12/case)	35	.88	1	---	---	---	---	---	---	58.0	64.9	40	57	85	85	143	286	572	687	1,430	
	Case of 1-qt cans																					
	(24/case)	60	1.6	2	---	---	---	---	---	---	33.4	37.3	20	33	50	50	83	166	333	400	835	
	Case of 5-qt cans																					
	(6/case)	77	1.9	2	---	---	---	---	---	---	26.0	29.1	20	26	39	39	65	130	260	312	660	

Greases	25-lb pail	29	.95	1	---	---	---	---	---	69.0	77.2	40.0	69	103	103	173	345	692	827	1,720
	5-lb can																			
	(6/case)	44	1.1	2	---	---	---	---	---	45.4	50.9	20.0	45	68	68	114	227	455	545	1,140

¹ Bulk petroleum products are measured in U.S. gallons or barrels. One barrel equals 42 U.S. gallons.

² Based upon authorized off-highway loads in short tons. When overloads are authorized, these quantities may be increased to the cubic capacity of the vehicle or to 100 percent overweight, whichever limit is reached first.

³ 18-gage standard, weighs 54 pounds empty, holds 54 gallons of light products and 55 gallons of heavy products. Federal Specification PPP-D-729, Amendment 1.

⁴ 16-gage standard, weighs 70 pounds empty, holds 54 gallons of light products and 55 gallons of heavy products. Federal Specification PPP-D-729, Amendment 1.

⁵ 18-gage limited standard, weighs 52 pounds empty, holds 53 gallons of light products and 54 gallons of heavy products. Federal Specification PPP-D-729.

⁶ For planning purposes, weight of gasoline may be taken as 42 pounds and weight of lubricating oil for engines at 50 pounds per 5-gallon can, including weight of can. An empty 5-gallon can weighs approximately 11 pounds.

3-51. Volume of Barracks Bags

The volume of barracks bags packed to capacity averages 4.4 cubic feet. The following capacities can be used for planning purposes. Quantities are based upon cargo space of vehicles, and can be increased by loading above sideboards for vehicles without closed top. Figures are based upon the assumption that the weight of the bags does not average over 50 pounds each. Should this weight be exceeded, appropriate adjustments must be made.

<i>Vehicle</i>	<i>Body cargo space (cu ft)</i>	<i>No. barracks bags</i>
Truck:		
½-ton pickup, 4x2, Chev ----	37	8
¾-ton, cargo, M37 -----	160	30
1 ½-ton, cargo, 4x4, Chev ---	258	60
2 ½-ton, 6x6, LWB, M36 ----	630	100
2 ½-ton, 6x6, M135 -----	408	87
2 ½-ton, 6x6, COE, 15 ft ----	475	100
2 ½-ton, 6x6, M35 -----	456	99

<i>Vehicle</i>	<i>Body cargo space (cu ft)</i>	<i>No. barracks bags</i>
2 ½-ton, 6x6, COE, 17 ft ----	540	100
5-ton, 6x6, cargo, M54 -----	515	112
Trailer:		
¼-ton, 2-wheel, M100 -----	28	6
¾-ton, cargo, M101 -----	175	30
1-ton, cargo, 2-wheel -----	113	20
1 ½-ton, cargo, M104 -----	283	59
Semitrailer:		
5-ton, S&P, 2-wheel -----	515	112
6-ton, van, 2-wheel, MGSW4 .	1,096	240
10-ton, S&P, 2-wheel -----	730	161
12-ton, M127 -----	830	184

3-52. Vehicle Size and Weight Limits

The charts below may be used as planning guides. Size and weight limits are changed periodically as a result of road and bridge construction. Planners must check with local military and/or civilian agencies to verify local limits and methods of clearance or exemption before putting vehicles on the road.

a. United States.

Compiled December, 1965, by National Highway Users Conference, National Press Bldg., Washington, D.C. 20004 as an addendum to NHUC Motor Vehicle Law Reporting Service No. 1.

Size restrictions

Length (feet)

*Gross weight limits
(in thousands of pounds)*

pneumatic tires only

State		Width (inches)	Height (feet)	Single unit	Trailer	Tractor semi-trailer	Other combinations	Number of trailers (semi-trailer— $\frac{1}{2}$)	Minimum tandem axle spacing	Pounds per inch of tire width	Per axle (1000 lb.)	Tandem axles 4 feet apart (1000 lb.)	2-Axle single unit	3-Axle single unit	2-Axle tractor 1-axle semi-tr.	2-Axle tractor 2-axle semi-tr.	3-Axle tractor 2-axle semi-tr.	Maximum allowable gross weight
Alabama	A	96	13½	40	NR ^J	55	NP	½	40	NS	18	36	36	54	54	72	73.2	73.2
Alaska	A	96	13½	40	35 ^F	60	65	2	40	500	18	32	29	43	47	61	75	76.8
Arizona	A	96	13½	40	40 ^I	65	65	1½	40	NS	18	32	36	50	54	68	76.8	76.8
Arkansas	C	96	13½	40	NR	55	55	NR	40	NS	18	32	30	44	48	62	73.2	73.2
California	A	96	13½	35 ^D	35 ^F	60	65	NR	NS	NS	18	32	36	50	54	68	76.8	76.8
Colorado	B	96 ^G	13½ ^O	35 ^D	NR	65 ^O	65 ^O	2	40	NR	18	36	30	46	54	66	73.6	73.6
Connecticut	C	102	12½	55	40 ^J	55	NP	½	NS	NS	22.4	36	32	53.8	53.8	67.4	73	73
Delaware	A	96	13½	40 ^D	40	55	60	1½	48	700	20	36	30	46	48	66	73.2	73.2
Dist. of Columbia	A	96	12½	40	NR	50	50	1 or ½	40	NS	22	38	44	60	66	70	70	70
Florida	A	96	13½	40 ^H	35 ^I	55	55	1 or ½	40	NS	20	40	40	60	60	66.6	66.6	66.6
Georgia	C	96	13½	55	NR	55	55	NR	40	NR	20.3	40.6	40.6	61	61	73.2	73.2	73.2
Hawaii	B	108	13	40	NR	55	65	1½	42		24	32	48	56	69.6	69.6	69.6	77.6
Idaho	A	96	14	35	NR	60 ^K	65	1½	NS	800	18	32	36	50	54	68	76.8	76.8
Illinois	C	96	13½	42	42	55 ^K	60	1½	40	NS	18	32	36	50	54	68	72	72
Indiana	C	96	13½	36 ^D	NR	55 ^K	65	2	40	800	18	32	36	50	54	68	72.6	72.6
Iowa	A	96	13½	35 ^D	NS	55 ^K	55 ^K	1½	40	NR	18	32	36	50	54	68	73.2	73.2
Kansas	A	96	13½	42½	42½	55 ^K	65 ^O	NR	40	NR	18	32	36	50	54	68	73.2	73.2
Kentucky	C	96	13½ ^O	35 ^O	NR ^J	55 ^O	NP	½	42	600	18	32 ^O	36 ^O	50 ^O	54 ^O	68 ^O	73.2 ^O	73.2 ^O
Louisiana	C	96	13½	35 ^D	NR	55	60	1 or ½	40	450	18	32	18 ^E	32 ^E	36 ^E	50 ^E	64 ^E	68 ^E
Maine	A	96 ^M	13½	55	NR	55	55	1 or ½	48	600	22	32 ^M	36	51.8	51.8	66.3	73.2	73.2
Maryland	A	102	13½	55	NR	55	55	NR	NS	NS	22.4	40	44.8	55	55	65	73.2	73.2
Massachusetts	A	96	NS	35	NR ^J	50	NP ^J	½	NS	800	22.4	36	44.8	58.4	60	73	73	73
Michigan	C	96	13½	35 ^D	40	55 ^K	55 ^K	1½	42	--	18	32 ^O	36	50 ^O	54	68 ^O	73.2 ^O	N
Minnesota	A	96	13½	40	40 ^I	50 ^K	50 ^K	1 or ½	40	NR	18	32	36	54	54	64	73.2	73.2
Mississippi	A	96	13½	35 ^D	NR	55	55	1 or ½	40	Table	18	32 ^O	36 ^O	50 ^O	46 ^O	60 ^O	73.2 ^O	73.2 ^O
Missouri	A	96	13½	40	NR	55 ^K	55 ^O	NR	40	600	18	32	36	50	54	68	73.2	73.2
Montana	A	96	13½	35 ^D	NR	60	60	1 or ½	40	NS	18	32	36	50	54	68	71.1	71.1
Nebraska	A	96	13½	40	40 ^I	60	65	2	40	NR	18	32	36	50	54	68	76.8	76.8
Nevada	A	96	NR	NR	NR	NR	NR	NR	42	NS	18	32	36	50	54	68	76.8	76.8
New Hampshire	A	96	13½	35 ^D	NR	55	55	NR	NS	600	22.4	36	33.4	47.5 ^M	55	66.4	73.2	73.2

Size restrictions

Length (feet)

Gross weight limits
(in thousands of pounds)

pneumatic tires only

State		Width (inches)	Height (feet)	Single unit	Trailer	Tractor semi-trailer	Other combinations	Number of trailers (semi-trailer— $\frac{1}{2}$)	Minimum tandem axle spacing	Pounds per inch of tire width	Per axle (1000 lb.)	Tandem axles 4 feet apart (1000 lb.)	2-Axle single unit	3-Axle single unit	2-Axle tractor 1-axle semi-tr.	2-Axle tractor 2-axle semi-tr.	3-Axle tractor 2-axle semi-tr.	Maximum allowable gross weight
New Jersey	C	96	13½	35	35 ^I	55	55	2	40	800	22.4	32	22.4 ^E	32 ^E	44.8 ^E	73.2	73.2	73.2
New Mexico	C	96	13½	40	NR	65	65	1½	40	600	21.6	34.3	43.2	55.9	64.8	77.5	86.4	86.4
New York	B	96	13 ^L	35 ^D	35 ^I	55	55	1 or ½	46	800	22.4	36	44.8	58.4	67.2	71	71	71
North Carolina	C	96	13½	35 ^D	NR	55	55	1 or ½	48	600	18	36	30	47.5	47.5	64	70	73.2
North Dakota	B	96	13½	40 ^H	NR	60	65 ^O	1½	40	550	18	32	36	50	54	64	64	64
Ohio	B	96	13½	35 ^D	35 ^F	55	60	NR	NS	650	19	32	38	51	57	70	75.8	78
Oklahoma	A	96	13½	40 ^D	NR	55	65	1½	40	650	18	32	18 ^E	32 ^E	36 ^E	50 ^E	73.2	73.2
Oregon	A	96	13½	35	35	50	65 ^O	1 or ½	40	550	18	32	36	50	36 ^E	50 ^E	760	760
Pennsylvania	C	96	13½ ^P	35 ^D	40	55 ^P	55 ^P	1 or ½	36	800	22.4	36	33	47	50	60	71.1	71.1
Rhode Island	C	102	13½	40	40 ^I	55	55	1 or ½	40	NS	22.4	NS	36	44	53.8	67.4	73.2	73.2
South Carolina	C	96	13½	40 ^H	NR	55 ^K	55	1 or ½	40	NR	20	32 ^M	32	46	50	65	73.2	73.2
South Dakota	A	96	13½	35 ^D	NR	65 ^O	65 ^O	1 or ½	40	600	18	32	36	50	54	68	73.2	73.2
Tennessee	C	96	13½	35 ^D	NR ^{JI}	50	50	½	40	NS	18	32	36	50	48	62	73.2	73.2
Texas	A	96	13½	40	40	55	65	NR	40	650	18	32	36	50	54	68	72	72
Utah	A	96	14	45	45	60	60	NR	40	NS	18	33	36	51	54	69	79.9	79.9
Vermont	A	96	13½	55	NR	55	55	1 or ½	48	600	22.4	36	30 ^M	40 ^M	50 ^M	60 ^M	60 ^M	60 ^M
Virginia	A	96	13½	35 ^D	NR	50	50	1 or ½	40	650	18	32	44.8	55	67.2	73.2	73.2	73.2
Washington	A	96	13½ ^L	35	40	60	65	1½	42	550	18	32	36	50	54	68	70	70
West Virginia	A	96	13½ ^{OL}	40 ^H	NR	55 ^O	55 ^O	1 or ½	40	NR	18	32	28	36	46	60	68	72
Wisconsin	A	96 ^G	13½	35 ^D	35	55	55	1 or ½	42	NS	18	32	36	50	54	70 ^O	70 ^O	70 ^O
Wyoming	A	96	13½	40	NR	65	65	2	40	NS	18	32	36	50	54	68	73	73

Key to Symbols—Footnotes

- A. Gross weight determined by table of axle spacing and/or sum of axle weight limits.
 B. Gross weight determined by bridge formula. See last page.
 C. Weight limits fixed by state law.
 D. Buses permitted length of 40 ft. in Colo., Ind., Iowa, Mich., Mont., N. H., Pa., S. D., Tenn., Va., Wisc.; 3 axle buses permitted 40 ft. in Calif., La., Miss., N. C., N. Y., Ohio; buses permitted 45 ft. in Okla., 42 ft. in Del.
 E. Plus weight on front axle.
 F. Semi-trailers 40 ft. in Alaska, Calif., Ohio.
 G. Bus width 102 in. Colo., 104 in. Wisc.
 H. Vehicles over 35 ft. in length, except buses, must have 3 axles in Fla., S. C.; vehicles over 35 ft. including buses, must have 3 axles in N. D. and W. Va.
 I. Semi-trailer length not restricted in Ariz., Fla., Minn., Nebr., N. J., N. Y., R. I., Tenn.; 3 axle trailers allowed 40 ft. in Fla.

J. Full trailers not permitted in Ala., Conn., Ky.; restricted to 3,000 lbs. and 33 ft. length in Mass., 3,500 lbs. in Tenn.

K. Auto transporter length 55 ft. in Minn., 60 ft. in Ill., Ind., Iowa (also double bottoms), Kans., Mo., Mich., S. C.; 65 ft. in Idaho on designated highways.

L. Auto transporter height $13\frac{1}{2}$ ft. in N. Y., W. Va.; 14 ft. in Wash.

M. Limit on Interstate System only.

N. Subject only to axle limits.

O. On designated highways.

P. Effective February 5, 1966.

NP—Not permitted.

NR—Not restricted.

NS—Not specified.

b. Canada.

<i>Province</i>	<i>Height (ft)</i>	<i>Width (ft)</i>	<i>Vehicle length (ft)</i>		<i>Axle load limits (lb)</i>		<i>Vehicle gross weight limits (lb)</i>
			<i>Single unit</i>	<i>Tractor and trailer</i>	<i>Single axle</i>	<i>2-axle tandem</i>	
British Columbia	13.5	8	35	50	18,000	32,000	76,000
Alberta	13.5	8	35	60	18,000	32,000	72,00
Saskatchewan	13.5	8	35	50	18,000	28,000	64,000
Manitoba	13.5	8	40	60	18,000	32,000	72,000
Ontario	13.5	8	33	50	18,000	30,000	70,000
Quebec	12.5	8	35	60	16,000	24,000	50,000
New Brunswick	12.5	8	35	60	18,000	30,000	70,000
Nova Scotia	12	8	36	65	18,000	26,000	56,000
Prince Edward Island	14.5	8	35	85	18,000	30,000	54,000
Newfoundland	No information available						
Yukon Territory	No information available						
Northwest Territories	No information available						

c. Europe.

Country	Width (ft)	Height (ft)	Single unit	Length (ft)		Axle load limits (lb)		Gross weight limits (lb)					Vehicle with trailer
				Truck tractor semitrailer	Other com- binations	Single	Tandem	2-axle vehicle	3-axle vehicle	4-axle articulated vehicle	5-axle vehicle		
Austria	7.87 ^a	12.5	36.09	45.93	59.05	17,637	28,660 ^b	28,660	39,684	44,092	55,113 ^c	72,752	
Belgium	8.20	13.12	39.37	45.93	72.18	38,660	44,092 ^d	41,887	57,302 ^e to 70,547	70,548	70,548	70,548	
Denmark	8.20	7.81	39.37	45.93	59.05	17,637	31,967	(^f)	(^f)	(^f)	(^f)	(^f)	
Finland	7.87	12.5	36.09	45.93	59.05	14,110	22,046	(^g)	(^g)	(^g)	(^g)	(^g)	
France	8.20	12.25	36.09	45.93	59.05 ^h	22,860	46,297	41,887 ⁱ	77,161 ^j	77,161 ^j	77,161 ^j	77,161 ^j	
Great Britain	8.09	15.0 ^k	29.99	35.0	----	20,150	24,625	31,305	44,753	53,792	71,650	71,650	
Italy	8.20	13.1	36.09	45.93	59.05	22,046	31,967	30,864	39,863 to 61,729	61,729	70,547 to 79,366	70,547 to 79,366	
Luxembourg	8.20	13.1	36.09 ^l	45.93	65.62	28,660	41,887 ^b	41,887	57,320	77,162	77,162 to 88,185	77,162 to 88,185	
Netherlands	8.20	12.5	36.09	45.93	59.05	17,637 ^m	35,273	-----	-----	-----	-----	-----	
Norway ^a	7.22 ^o	-----	-----	-----	-----	4,409 ^o	4,409	-----	-----	-----	-----	-----	
Poland	8.20	13.1	-----	-----	-----	17,637	30,864	30,864 ^p	44,093 ^p	57,320 ^p	-----	-----	
Portugal	8.04	13.1	32.81	39.37	45.93	22,046	36,376	33,069	44,092	44,092	44,092	77,162	
Spain	8.24	14.6	39.37	32.81 ^q	32.81 ^q	22,046 to 26,456	33,069 to 44,092	33,069	33,069 to 55,116	33,069 to 59,525	33,069 to 59,525	33,069 to 59,525	
Sweden	7.71 to 8.20	-----	-----	-----	-----	13,228 to 17,637	17,637 to 26,456	(^r)	(^r)	(^r)	(^r)	(^r)	
Switzerland	7.55 ^s to 8.20	13.1	32.81	45.93	59.05	22,046	-----	35,273	46,297	57,320	57,320	57,320	
West Germany ^t	8.20	13.1	36.09	49.2	54.13	17,637 ^u to 22,050	26,455 ^v to 35,280	26,455	52,840	52,920	77,180	88,200	

^a For buses, 98.42 in. For bus trailers, 96.45 in. For other trailers, 92.52 in.

^b Maximum 22,046 lb per axle.

^c For truck or bus with trailer, 72,752 lb.

^d Maximum 28,660 lb per axle.

^e For 3-axle truck, 57,320 lb. For tractor truck semitrailer, 72,750 lb.

^f Maximum weight depends on the distance between the center axles.

^g Weight of 22,406 lb plus 308.64 lb for every 3.94 in. of the distance between the foremost and rearmost axles of a vehicle or the combination of vehicles exceeding 6.56 ft.

^h With special considerations in urban and suburban traffic, 65.62 in.

ⁱ The weight per 39.37 in. between the outer axles cannot be greater than 11,023 lb.

^j For 3-axle trailer, 57,320 lb; for tractor truck semitrailer, 77,161 lb.

^k Only for buses.

^l Can be increased to 39.37 ft if the back projection is not larger than six-tenths of the wheelbase or 14.48 ft.

^m In axles with four single wheels (dual wheels are considered as one) 35,273 lb.

ⁿ Exemptions granted for certain roads to 7.71 ft wide and 15,432 lb per axle.

^o Exemptions from restrictions on vehicle width and axle weight are granted upon application. They permit 86.61 in. width and 8,818 lb axle weight, 88.58 in. width and

11,023 lb axle weight, and 95.52 in. width and 13,228 lb axle weight, respectively, and refer to a great number of specifically indicated roads. Exemptions up to an axle weight of 15,432 lb can be granted on certain main roads.

^p Axle spacing, 118.11 in.

^q In special cases, 45.93 ft.

^r Gross weight limit dependent on axle distance.

Axle distance (ft)	Gross weight limits (lb)
16.41	26,455 to 35,274
32.81	39,683 to 48,502
49.22	52,911 to 61,729
65.62	68,343 to 77,162

^s On secondary streets, 86.61 in. On special roads for foreign buses, 94.42 in. Trucks 94.48 in.

^t Regulation in force 1-7-60. Certain exemptions granted to vehicles registered prior to 1-1-58.

^u Driving axle 22,046 lb, others 17,637 lb.

^v Axle distance less than 4.27 ft, 31,967 lb. Greater axle distance, 35,274 lb.

3-53. Preparation of Vehicles for Air Movement

a. Units which must be ready for immediate movement by air should make preparations well in advance to avoid delays in the loading of vehicles into the transporting aircraft. Essential items of information that must be available are—

- (1) Weight of vehicle (with load),
- (2) Dimensions of vehicle.
- (3) Center of gravity of loaded vehicle.

b. The dimensions of the vehicle may be obtained from the vehicle technical manual. Since unit equipment will be loaded on vehicles for air shipment in accordance with a prescribed loading plan, the center of gravity will have to be computed for each vehicle. Actual weighing and computation may be made during loading plan tests. After a vehicle has been loaded in accordance with the unit loading plan, its center of gravity should be marked on the exterior of the vehicle with crayon or waterproof tape.

c. Figure 3-31 illustrates method of determining the weight and center of gravity location of single- and multi-unit vehicles.

3-54. Vehicle Weight and Dimension Card

The NATO Armed Forces have agreed to adopt for the transportation of their vehicles the card as shown in figure 3-32.

a. The front will be printed in white on a black background. (When printed forms are not immediately available, a substitute card printed and completed in black on a white background.)

b. The border of the front will be gummed so as to facilitate affixing to windshields.

c. The card is to be printed in both the official NATO languages (English and French) and in the language of the country of origin if other than English or French.

d. The size of the card is $9\frac{1}{2}$ inches (24 cm) $\times$ $7\frac{1}{4}$ inches (18 cm).

e. The method by which the card will be employed is shown on the reverse of each card (fig. 3.32).

3-55. Transportation Motor Pool Layout and Facilities

The basic layout of motor pools may vary depending on space and existing conditions. The typical motor pool should include the facilities shown in *a* through *i* below.

Note. In cases of new construction, the use of a single structure is advocated. This promotes substantial economies in construction costs and operations.

a. *Office.* The motor pool office should be located in the motor pool operations area.

b. *Dispatch Office.* All vehicular operations are controlled through this office. If at all possible, it should be located at the exit of the motor pool, thereby allowing the dispatcher to visibly check vehicles leaving the parking area.

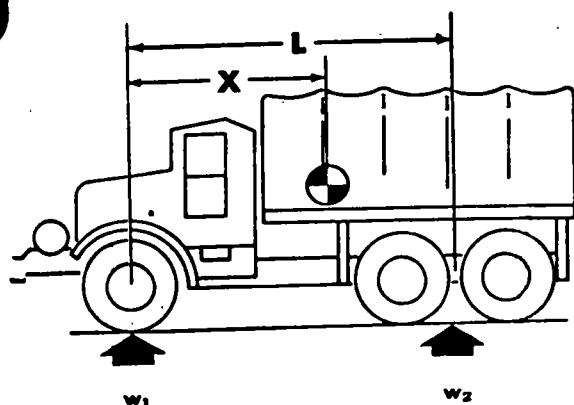
c. *Driver's Room.* The driver's room is conveniently located in the vicinity of the dispatch office but, for reasons of orderly operation, separate from the main dispatch office.

d. *Emergency Repair Facility.* This facility performs minor and emergency repairs that are not serious enough to warrant removal of the vehicle from operation. It is usually located in a section of the general repair shop or at the POL point.

e. *Vehicle Washing Facilities.* Such facilities should be available for use under all weather conditions. Facilities should be so located that drainage away from parking areas and buildings is provided. The use of automatic washing facilities should be considered when feasible.

f. *Preventive Maintenance and General Repair Shop.* The number of vehicles serviced will be a deciding factor in the type of shop used. The primary function of the shop should be to accomplish regularly scheduled preventive maintenance, lubrication, and general repair activities.

g. *Allied Trade Shops.* Shops for spot painting, minor body work, carpentry, and welding are set up at the motor pool. Because of the fire hazard existing in some trade shops, further segregation of this facility is often required. For example, painting and welding activities should not be performed in close proximity.



$$X = \frac{L w_2}{W}$$

WHERE

X = Distance from front axle to unit center-of-gravity location

L = Wheelbase

w₁ = Front axle load

w₂ = Rear axle load

W = Total weight of unit

TO LOCATE CARGO UNIT CENTER OF GRAVITY, DETERMINE X

1. Determine axle loads by weighing all axles (w₁ and w₂).

Note

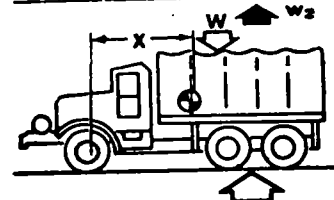
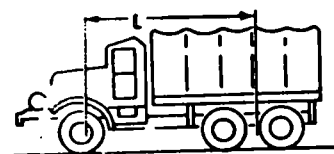
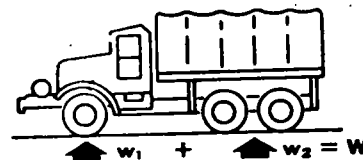
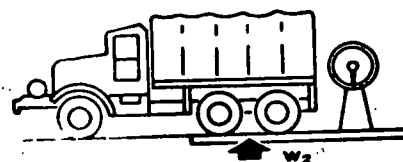
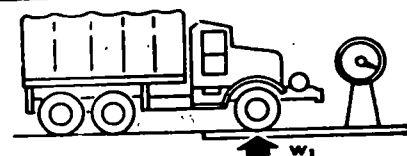
Vehicle must be level when weighing.

2. Determine total weight of unit (W) by adding axle loads (w₁ and w₂).

3. Determine wheelbase (L).

4. Determine rear axle moment about front axle by multiplying rear axle load (w₂) by wheelbase (L).

5. Determine center-of-gravity distance from front axle (X) by dividing rear axle moment by total weight (W).



REAR AXLE MOMENT

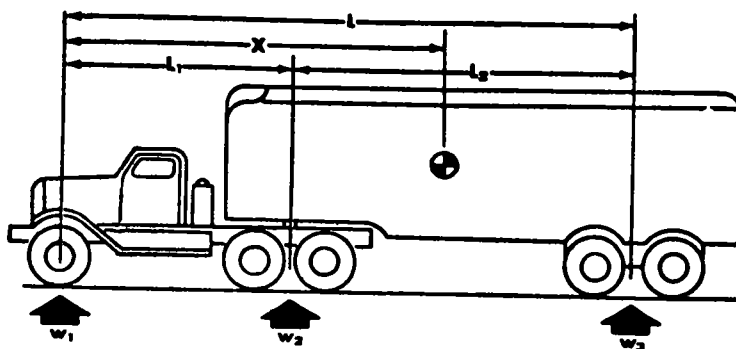
VEHICLES

Figure 3-31. Determining cargo unit weight and center of gravity.

$$X = \frac{L_1 w_2 + L w_3}{W}$$

WHERE

- X** = Distance from front axle to unit center-of-gravity location
w₁ = Front axle load
L₁ = Tractor wheelbase
w₂ = Tractor rear axle load
L₂ = Trailer wheelbase
w₃ = Trailer axle load
L = Total wheelbase of unit
W = Total weight of unit



TO LOCATE CARGO UNIT CENTER OF GRAVITY, DETERMINE X

1. Determine axle loads by weighing all axles (**w₁**, **w₂**, and **w₃**).

Note

Vehicle must be level when weighing.

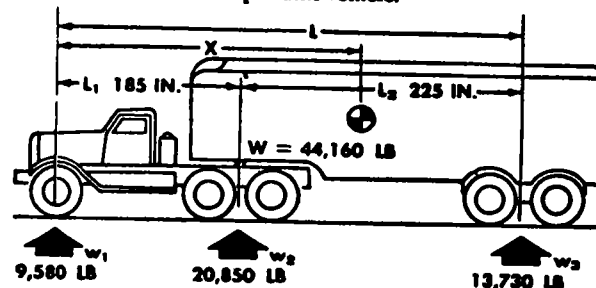
2. Determine total weight of unit (**W**) by adding all axle loads.
3. Determine tractor wheelbase (**L₁**) and trailer wheelbase (**L₂**).
4. Determine total wheelbase of unit (**L**).
5. Determine tractor rear axle moment about front axle by multiplying tractor wheelbase (**L₁**) by tractor rear axle load (**w₂**).
6. Determine trailer axle moment by multiplying total wheelbase (**L**) by trailer axle load (**w₃**).
7. Determine total moment about front axle by adding trailer axle moment and tractor rear axle moment.
8. Determine center-of-gravity distance from front axle (**X**) by dividing total moment by total weight (**W**).

Notes:

As an aid to load planning, it may be desirable to know relationship of vehicle center of gravity to vehicle extremities. To determine distance from front bumper to center of gravity, add distance between front bumper and front axle to value determined in step 8. To determine distance between aft end of vehicle and center of gravity, subtract value determined in step 8 from distance between front axle and aft end of vehicle.

SAMPLE PROBLEM

GIVEN: A multiple-unit vehicle.



PROBLEM: Determine center-of-gravity location.

SOLUTION:

1. **w₁** = 9,580 pounds
w₂ = 20,850 pounds
w₃ = 13,730 pounds
2. **W** = 9,580 + 20,850 + 13,730 = 44,160 pounds
3. **L₁** = 185 inches
L₂ = 225 inches
4. **L** = 185 + 225 = 410 inches
5. 185 × 20,850 = 3,857,250
6. 410 × 13,730 = 5,629,300
7. 3,857,250 + 5,629,300 = 9,486,550
8. 9,486,550 ÷ 44,160 = 214.8

CONCLUSION:

Cargo unit center of gravity is located 214.8 inches aft of front axle.

MULTIPLE-UNIT VEHICLES

Figure 3-31—Continued.

(Example--Front)

VEHICLE WEIGHT AND DIMENSION CARD

FICHE DE DIMENSIONS ET DE POIDS DU VEHICULE

----- (3d language/3ème langue)	
	State unit of measure used. Préciser l'unité de mesure utilisée. ----- (3d language/3ème langue).
WEIGHT POIDS ----- (3d language/3ème langue)	-----
LENGTH LONGUEUR ----- (3d language/3ème langue)	-----
BREADTH LARGEUR ----- (3d language/3ème langue)	-----
HEIGHT HAUTEUR ----- (3d language/3ème langue)	-----
GROUND PRESSURE OR MAXIMUM AXLE LOAD PRESSION UNITAIRE OU POIDS DE L'ESSIEU LE PLUS CHARGE ----- (3d language/3ème langue)	-----

Figure 3-32. Vehicle weight and dimension card.

h. Supply and Parts Room. This facility is centrally located within the main shop building to provide easy access to parts and tools. Parts, bins, tool racks, and an appropriate issue counter should be provided.

i. Public Address System. A public address

system facilitates control of the motor pool or parking area. Interoffice communication between the dispatch office and key locations within the pool area eliminates many unnecessary, time-consuming trips and contributes to more orderly execution of assigned duties.

(Example--Back)

Directions for Use

Mode d'emploi

1. This card is designed to display vehicle laden weight and dimensions to all concerned with loading it on any means of transport, e.g., to an aircraft, ship, etc.
1. Cette fiche est destinée à indiquer le poids en charge et les dimensions d'un véhicule à tous ceux qui peuvent être responsables de son chargement sur n'importe quel mode de transport, par exemple: avion, navire, etc.
1. _ _ _ _ _ (3d language/3ème langue) _ _ _ _ _
2. Accurate weight and dimensions will be printed in chalk by the unit or depot preparing a vehicle for movement. This card will then be fixed inside the windscreen on the passenger's side. On tanks or other vehicles without windscreens, this card will be fixed on a suitable surface on the opposite side of the vehicle from the driver's seat, where it can be easily seen. If possible, it should be protected from inclement weather.
2. Le poids et les dimensions exacts seront indiqués à la craie, en lettres majuscules, par l'unité ou le dépôt préparant le véhicule en vue de son transport. Cette fiche sera ensuite apposée à l'intérieur du pare-brise, du côté du passager. Dans le cas des chars ou autres véhicules sans pare-brise, la fiche sera apposée sur une surface appropriée sur le côté du véhicule opposé à celui du siège du conducteur et dans une position facilement visible. Si possible, la fiche doit être à l'abri des intempéries.
2. _ _ _ _ _ (3d language/3ème langue) _ _ _ _ _
3. This is a NATO form and whoever "chalks in" the weights and dimensions should use his country's normal system of weight and measurement.
3. Cette fiche est un formulaire OTAN et la personne chargée d'inscrire la craie le poids et les dimensions du véhicule doit utiliser le système normal de poids et mesures de son propre pays.
3. _ _ _ _ _ (3d language/3ème langue) _ _ _ _ _

Figure 3-32—Continued.

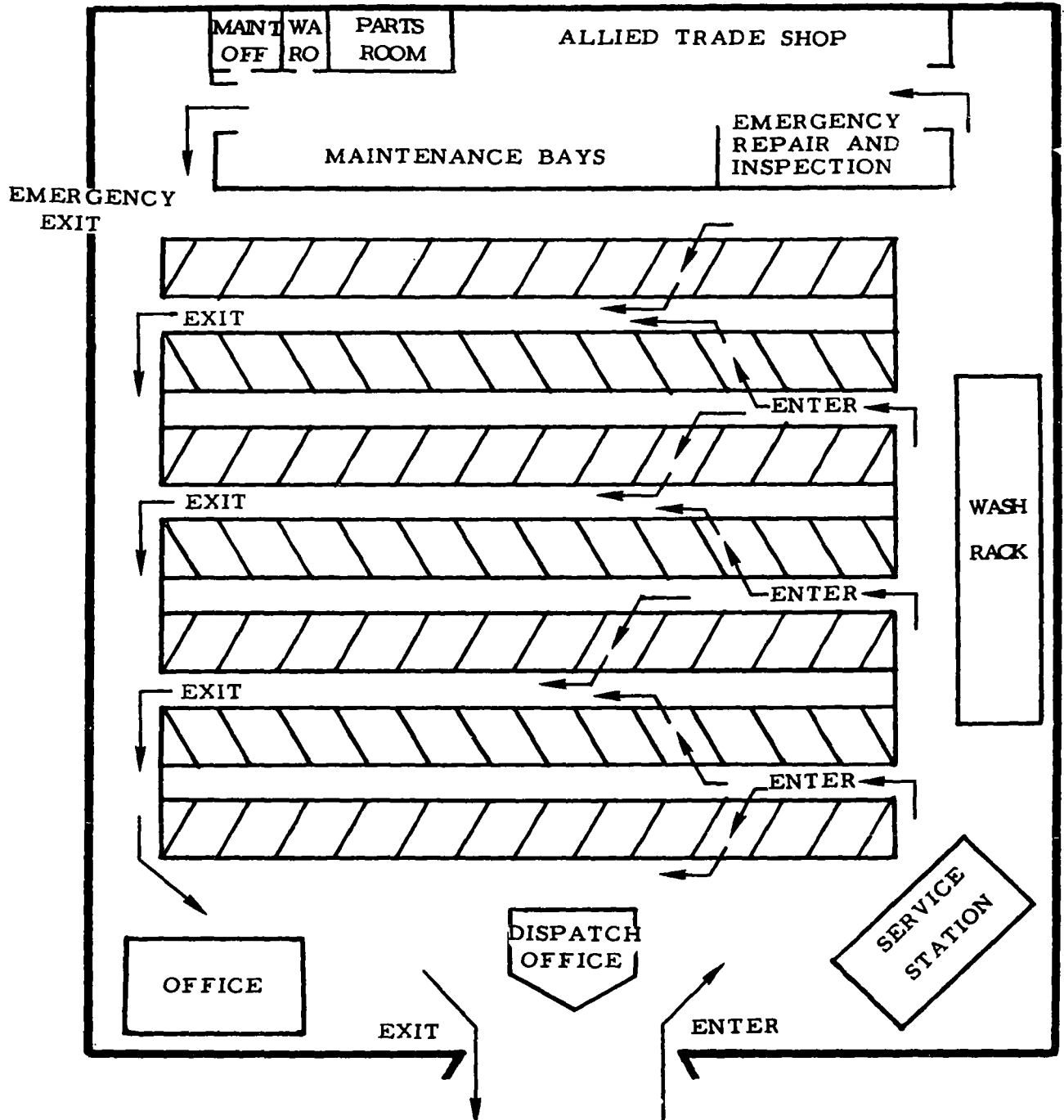


Figure 3-33. Motor pool parking plan.

CHAPTER 4

RAIL

Section I. ORGANIZATION

4-1. Organization of Transportation Railway Service (TRS)

(fig. 4-1)

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
General headquarters, transportation railway service.	55-200	To direct the operation and maintenance of railways used for military purposes in a large theater of operations.	To a theater support command or to a theater army logistical command.	Provides: a. Overall supervision and direction of all railroads of any theater of operations, and b. Command of all troops assigned to transportation railway service.
Headquarters and headquarters company, transportation railway brigade.	55-201	To command and provide operational planning, supervision, coordination, and control of the activities of transportation railway groups.	To a theater support command or to a theater army logistical command or general headquarters, transportation railway service.	Provides command and supervision of two or more transportation railway groups, TOE 55-202.
Headquarters and headquarters company, transportation railway group.	55-202	To command, administer, and supervise the operations of railway battalions and attached units.	To a theater support command or to a theater army logistical command or field army. Normally assigned to headquarters and headquarters company, transportation railway command or may operate separately under the supervision of the appropriate staff transportation officer.	Provides command and supervision for from two to six transportation railway battalions and transportation railway maintenance units as required.
Transportation railway battalion.	55-225	To operate and maintain a railroad division in a theater of operations.	To transportation railway group.	During phase I operations (complete military operation of the railroad): a. Operates 40 locomotives per day in road and yard service over approximately 90 to 150 miles of railroad; b. Operates a railway classification yard for the formation of trains;

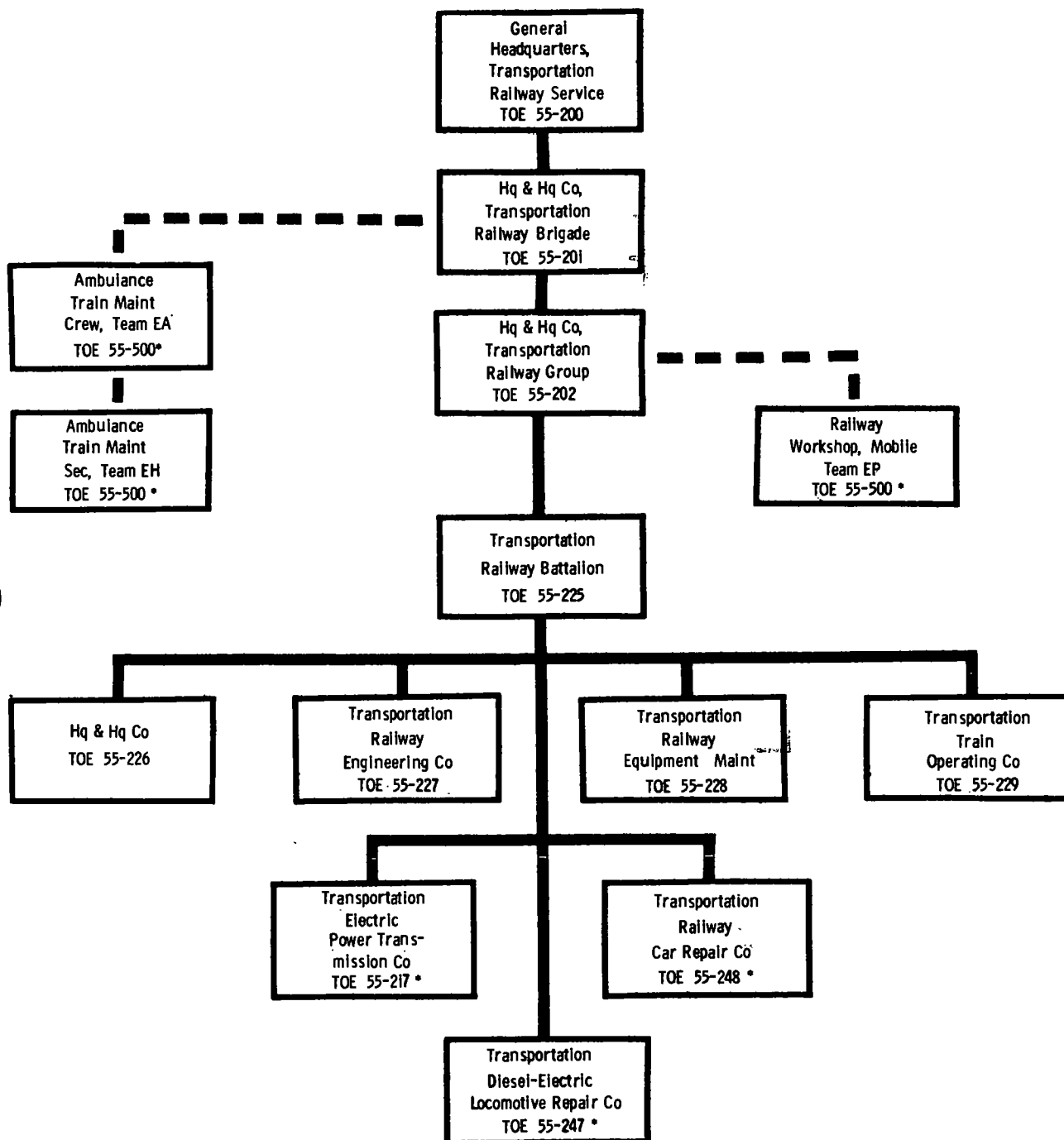
<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Headquarters and headquarters company, transportation railway battalion.	55-226	To exercise command, control and administration of organic and attached units of the transportation railway battalion.	To a theater support command organic to the transportation railway battalion.	c. Inspects, conditions, and performs up to general support maintenance on approximately 40 locomotives and 800 railroad cars; performs running inspections of approximately 2,000 railroad cars per day; and repairs tools and mechanical equipment of all companies within the battalion; d. Inspects and maintains approximately 90 to 150 miles of railway right-of-way; and e. Inspects and repairs wire communications used for train movements; provides organizational maintenance on organic equipment.
Transportation railway engineering company.	55-227	To maintain and repair railway track, bridges, buildings, and railway signals and communications within a railway division.	Organic to transportation railway battalion.	a. Provides command, staff planning, administration, control, and supervision of operations of the transportation railway battalion and assigned and attached units; b. Dispatches all trains operated by the battalion and supervises M-line operators; and c. Operates railway stations and signal towers which are the responsibility of the battalion. Performs maintenance and repair of track, railway signals, electrical communications, bridges, and structures of a railway division on a 24-hour basis.
Transportation railway equipment maintenance company.	55-228	To inspect, service, and make running repairs to diesel-electric locomotives and rolling stock.	Organic to transportation railway battalion.	a. Services and makes running repairs to approximately 40 diesel-electric locomotives and 800 railway cars on an around-the-clock basis; b. Performs running inspection for 2,000 railway cars daily; and c. Performs light repairs to tools and limited repairs to special

Transportation railway train operating company.	55-229	To provide road and yard personnel for the operation of railway locomotives and trains.	Organic to transportation railway battalion.	mechanical equipment within the battalion.
Transportation electric power transmission company.	55-217	To maintain and repair electric power transmission facilities for the transportation railway battalion.	To a transportation railway battalion where electric motive power is operated by means of electrified catenary when required and authorized by Department of the Army.	At full strength, provides 40 train-crews daily in either road or yard service operating 90 to 150 miles of railroad.
Transportation diesel-electric locomotive repair company.	55-247	To perform general support maintenance and inspection of diesel-electric locomotives and cranes.	To a transportation railway group.	Maintains and repairs electric power transmission facilities including substations and catenary for 200 miles of electrified railway including sidetracks, passing tracks, and yard tracks.
Transportation railway car repair company.	55-248	a. To perform general support of railway rolling stock, and b. To supply repair parts for organizational and direct support maintenance of railway equipment when sources of supply are not otherwise assigned in an area of operation.	To a transportation railway group.	Performs depot maintenance in support of 200 diesel-electric locomotive units and railway cranes.
Transportation depot company.	55-260	To receive, store, and issue all Transportation Corps items of supply.	To a section of the communications zone; may be attached to the Transportation Corps section of a depot or may operate separately as required.	a. Performs general support maintenance involving stripping, fabricating, assembling, erecting, and painting in support of 2,500 railway cars; b. Assembles boxcars, flatcars, gondola cars, tank cars, hospital cars, passenger cars, and special-purpose cars; and c. Receives, stores and issues 8,000 line items of supply per month.
Team EA, ambulance train maintenance crew.	55-500	To perform running repairs on ambulance train railway cars.	To the senior transportation railway unit in a theater of operations.	Receives, stores, and issues 100 tons of transportation items of supply daily or 2,000 line items of supply per month.
Team EH, railway yard operating detachment.	55-500	To operate a railway yard.	To a transportation railway battalion or comparable unit.	Performs running repairs on one ambulance train.
				a. Operates a railroad yard on a 24-hour basis when yard train-crews are provided and when not more than two receiving and classification yards including humps, etc., are to be operated; b. Inspects and performs running repairs on rolling stock transiting the yard; and

1

<i>Unit</i>	<i>TOE</i>	<i>Mission</i>	<i>Assignment</i>	<i>Capability</i>
Team EI, railway workshop —mobile.	55-500	To perform general support of diesel-electric locomotives and rolling stock in areas where static facilities are inadequate or nonexistent.	To headquarters and headquarters company, transportation railway group or to a transportation railway battalion or comparable unit.	c. Inspects and, as necessary, adjusts or secures loads on cars passing through the yard. Performs the following functions on a 24-hour basis: a. Inspecting and performing field maintenance on 20 diesel-electric locomotives and 100 railway cars; and b. Assembling railway equipment*

FM 55-15



*Assigned as required

Figure 4-1. Organization of the transportation railway service.

Section II. EQUIPMENT

4-2. Whyte Classification System of Locomotives

The locomotives described in this section are classified according to the Whyte system, which classifies locomotives according to the arrangement of their wheels. A series of numerals separated by hyphens is used to designate the total number of wheels on the axle of each type of locomotive truck—the front (leading) truck, driving wheel group, and rear (trailing) truck, respectively. The figures always describe the locomotive's wheels from front to rear; the wheels of the locomotive tender are not counted in the classification of 2-8-2 indicates one pair of leading wheels, four pairs of coupled driving wheels, and one pair of trailing wheels. The absence of any of the three types of wheels is always denoted

by a zero; thus a 2-8-0 locomotive has no trailing wheels. Diesel locomotives may also be classified by this system; figures such as 0-6-6-0 indicate no leading or trailing wheels and two sets of three driving axles each, or a total of 12 driving wheels. The classification commonly used in Europe and other parts of the world, however, classifies a diesel or electric locomotive by letters and figures. A diesel 0-4-4-0 is classified B-B; a 0-6-6-0 is designated C-C, etc. Idler wheels (those which exert no tractive effort) and leading and trailing wheels are designated with numbers. A single-unit locomotive with two six-wheel trucks in which the center wheel is an idler would be designated as A1A-A1A. An electric locomotive four-wheel leading and trailing trucks and six driving wheels would be designated 2-C/C-2.

4-3. Characteristics of Railway Equipment

a. Locomotives.

(1) Steam.

Type	Gage (in.)	Locomotive	Weight, loaded (lb) Tender	On drivers	Tractive force (lb)	Drawbar pull (lb)	Curvature, min radius (ft)	Fuel capacity 11-ton coal or 2,000-gal. oil	Water capacity 7,500-gal. tender
82-ton, 2-8-0	56½, 60, 63, 66	165,000	133,575	143,000	34,000 (85% boiler pressure)	42,000 (approx.)	231		
80-ton, 0-6-0	56½	160,000	133,575	160,000	40,000	38,400	193	Same as above	Same as above

(2) Diesel-electric.

Type	Gage (in.)	Weight locomotive (lb)	Tractive force (lb) Starting at 80-percent adhesion	Continuous	Horsepower	Curvature, min radius (ft)	Fuel capacity (gal.)
131-ton, 0-6-6-0, domestic and foreign service --	56½	262,000	75,700	(*)	1,000	231	1600
127-ton, 0-6-6-0, domestic and foreign service --	56½	254,000	75,700	37,850 (*)	1,000	231	1600
120-ton, 0-4-4-0, domestic service -----	56½	240,000	72,000	35,000 at 10 mph	1,200	193	1600 w/o trailer 800 w/o trailer
120-ton, single engine, 0-4-4-0, domestic serv- ice.	56½	240,000	72,000	34,000 at 8.3 mph	1,000	75	700
120-ton, 0-4-4-0, domestic service -----	56½	240,000	72,000	(*)	1,500	150	
120-ton, 0-6-6-0, foreign service -----	56½, 60, 63, 66	240,000	72,000	36,000 45,000 at 10 mph	1,600	193	1600
115-ton, 0-4-4-0, domestic service -----	56½	230,000	69,000	(*)	1,000	50	635
100-ton, 0-4-4-0, domestic service -----	56½	200,000	59,700	34,500 (*)	660	50	635
80-ton, 0-4-4-0, dual engine, domestic service --	56½	161,000	48,000	29,850 21,000 at 5.2 mph	470	75	300 or 400
76-ton, 0-6-6-0, foreign service -----	36, 39%, 42	152,000	45,000	(*)	975	100	800
65-ton, 0-4-4-0, domestic service -----	56½	130,000	39,000	22,500 (*)	400	75	250
60-ton, 0-4-4-0, foreign and domestic service --	56½, 60, 63, 66	122,000	36,000	19,500 15,680 at 7.28 mph	450	75	500
58-ton, 0-4-4-0, foreign service -----		116,000	36,000	(*)	400	75	500
48-ton, single-engine, 0-4-4-0, foreign service ...	36, 39%, 42	115,000	34,500	18,000 15,680 at 7.28 mph	400	75	500
45-ton, side-rod drive, 0-4-4-0, domestic serv- ice.	56½	90,000	27,000	(*)	300	50	165

Type	Gage (in.)	Weight, loaded (lb)		On drivers	Tractive force (lb)	Drawbar pull (lb)	Curvature, min radius (ft)	Fuel capacity		Water capacity
		Locomotive	Tender							
45-ton, 0-4-4-0, domestic and foreign service					90,000	27,000	(^a)	380	75	
44-ton, 0-4-4-0, domestic service				56½	88,000	26,400	13,500 (^a)	380	75	250
25-ton, 0-4-0, domestic service				56½	50,000	15,000	13,200 (^a)	150	50	75
25-ton, 0-4-0, foreign service				42	50,000	15,000	6,200 at 6.2 mph (^a)	150	40	75
							6,200 at 6.2 mph			

^a For diesel-electric power, the continuous TE is approximately half of the starting TE.

^b Reduced to 800 if equipped with Clarkson vapor heater.

(3) Gasoline-mechanical and diesel-mechanical.

Type	Gage (in.)	Weight (lb)	Drawbar pull (lb)	Horsepower (total engine)	Curvature, min radius (ft)	Fuel capacity (gal.)
10-ton, single-engine, 0-4-0, domestic service	56½	20,000	-----	100	75	30 (diesel)
5-ton, single-engine, 0-4-0, foreign and domestic service ----	36	11,000	2.7 mph—2,500 12 mph—875	34	20	15 (gasoline)

b. Boxcars.

Type	Gage (in.)	Capacity		Inside dimension			Door dimensions	Tare weight (STON)
		(lb)	(cu ft)	Length	Width	Height		
8W, narrow gage, foreign service --	36, 39¾, 42	60,000	1,588	34' 5½"	7'¾"	6'4"	7'10¼" wide	13.6
8W, domestic service	56½	100,000	3,975	40'6"	9'2"		6'1-16" high	
8W, broad gage, foreign service ----	56½, 60, 63, 66	80,000	2,520	40'6"	8'6"	6'5½"	6' wide, clear opening	23
							8' high, clear opening	
							8'3¼" high	18.5
							6'8¾" wide	

c. Open-Top Cars.

(1) Flatcars.

Type	Gage (in.)	Normal capacity (lb)*	Platform length*	Platform width*	Platform height above rail	Tare weight (STON)
8W, narrow gage, foreign service	36, 39¾, 42	60,000	34'8½"	7'2"	3'7"	10.9
12W, domestic service	56½	200,000	54'	10'6½"	4'1¼"	35
8W, domestic service	56½	140,000	49'11½"	10'3¼"	3'8½"	27
12W, broad gage, foreign service, 80-ton	56½, 60, 63, 66	160,000	46'4"	9'8"	4'2¾"	35.3
12W, domestic service (passenger train service) ----	56½	200,000	54'	10'6¼"	4'5¾"	
8W, domestic service	56½	100,000	43'3"	10'6"	3'8"	25.5
8W, broad gage, foreign service	56½, 60, 63, 66	80,000	40'9"	8'7¼"	3'6 15-16"	14.5
8W, broad gage, depressed center, foreign service ----	56½, 60, 63, 66	140,000	50'7"	9'8"		41.5

*To determine vehicle-carrying capacity of flatcars, use these three columns in conjunction with the information contained in paragraph 3.2. Determine first the number of vehicles by type that will fit on the flatcar bed. Then check their combined weights (including any cargo in the vehicles) against the weight capacity of the car. Either the platform dimensions of the flatcar or its weight-carrying capacity is the controlling factor. Side sills of flatcars must be considered in determining ability to carry tracked vehicles such as tanks, where the total loaded weight is resting on the outer edge of the car deck.

(2) Gondolas.

Type	Gage (in.)	Capacity		Inside dimensions			Tare weight
		(lb)	(cu ft)	Length	Width	Height	(STON)
High side, 8W, narrow gage, foreign service -----	36, 39½, 42	60,000	940	34'5"	6'10½"	4'	13
Low side, 8W, narrow gage, foreign service -----	36, 39½, 42	60,000	356	34'6"	6'10½"	1'6"	12.1
High side, 8W, broad gage, foreign service -----	56½	80,000	1,680	40'	8'3¾"	4'	18
Low side, 8W, broad gage, foreign service -----	56½, 60, 63, 66	80,000	500	40'4½"	8'3¼"	1'6"	16
Low side, 8W, drop ends, domestic service -----	56½	100,000	1,184	41'6"	9'6½"	3'	23
High side, std gage, domestic service -----	56½	100,000	1,580	41'6"	9'6"	4'6"	25

(3) Hopper car.

Type	Gage (in.)	Normal capacity (lb)	Length	Width	Height
8W, domestic service -----	56½	100,000	33'	9'5½"	9'7"

d. Tank Cars.

Type	Gage (in.)	Length over tank heads	Normal capacity (gal.) ¹	Inside diameter (in.)		Tare weight (STON)
				Tank ²	Dome	
Nickel-clad, ICC-103-AW, 8W, domestic service -----	56½	31'11"	7,500	78, approx	45	
ICC-103, ICC-103-W, 8W, domestic service -----	56½	34', approx	10,000	87, approx	59½, approx	
Caustic soda, ICC-103-W, 8W, domestic service -----	56½	34', approx	10,000	88, approx	64	
Petroleum, 8W, narrow gage, foreign service -----	36, 38¾, 42	38'4⅞"	6,000	62½	54	16
Petroleum, 8W, broad gage, foreign service -----	56½, 60, 63, 66	38'5⅝"	10,000	80¾	66½	19
Nitric acid, ICC-103-W, 8W, domestic service -----	56½	33'7½"	7,800	78, approx	35¾	
Phosphorus, ICC-103-W, 8W, domestic service -----	56½	34'8¼"	8,000	78, approx	64	
Petroleum, std gage, domestic service -----	56½	-----	10,000	-----	-----	23

¹ Specific gravity of a liquid should be checked before it is loaded to avoid exceeding weight capacity of car.

² See paragraph 7-24 for liquid volume in partially filled tank cars.

e. Refrigerator Cars.

Type	Gage (in.)	Normal capacity (lb)	Length inside end lining	Width inside side lining	Ice capacity (lb)	Dimensions of doors
8W, disassembled, foreign service -----	56½	80,000	38'9½"	6'11"	11,000	4' wide 7' high
8W, disassembled, broad gage, foreign service ----	56½, 60, 63, 66	80,000	32'½"	7'8", approx	11,000	4' wide 7' high
8W, mechanical, foreign service -----	56½, 60, 63, 66	80,000	40'9", equipment compartment	7'6", approx	None	6' wide 7' high

f. *Special-Purpose Cars.*

Type	Gage (in.)	Weight (lb)		Over end sills		Height above rail	Remarks
		Light	Loaded	Length	Width		
Car, amb unit, 8W, domestic service ---	56½	157,000	167,300	78'11"	10'	13'6"	Capacity: 27 patients, 6 corpsmen, 1 nurse, 1 doctor.
Car, kitchen, troop/amb train, 8W, domestic service -----	56½	100,160	-----	*54'2½"	9'5¾"	13'6"	
Car, kitchen, dining and storage, amb train, 8W, foreign service -----	56½, 60, 63, 66	111,400, avg	-----	63'¼"	9'	13'	Width, side door openings: 6'. Seat capacity: 24.
Car, ward, amb train -----	56½, 60, 63, 66	111,400, avg	-----	63'¼"	9'	13'	Berth capacity: 30.
Car, personnel, amb train -----	56½, 60, 63, 66	111,400, avg	-----	63'¼"	9'	13'	Berth capacity: 15 EM's, 4 doctors, 2 nurses.

*Includes couplers.

g. *Cranes.*

Type	Gage (in.)	Weight (lb)	Boom length (ft)	Boom height (down)
Wrecking, steam, 75-ton, broad gage, foreign service -----	56½, 60, 63, 66	191,000	25, 2-piece, curved	12'3¾"
Locomotive, diesel-mechanical, 25-ton, broad gage, domestic and foreign service -----	56½, 60, 63, 66	148,000	50, 2-piece, straight	13'6" max.
Locomotive, diesel-mechanical, 40-ton, broad gage, foreign service -----	56½, 60, 63, 66	210,000	50, 2-piece, straight	13'6" max.
Locomotive, diesel-mechanical, 25-ton, narrow gage, foreign service -----	36, 39¾, 42	161,000	40, 2-piece, straight	10'10"

4-4. **Dimensions, Weight, and Capacities of Typical U.S. Freight Cars**

There are no standard dimensions for commercial cars. The figures given are for types in common use. The 40-ton stock car comes in many lengths, varying from 35' 7" to 41' 10". All types have similar variations in capacity and dimensions.

Type	Tons	Men (8 sq ft per man and equipment)	Capacity Animals (horses, mules, oxen—avg width, 22 inches)	Cubic feet	Weight empty (tons)	Inside dimensions (ft)		
						Length	Width	Height
Automobile -----	40	45	22	3,100	20	40.5	8.5	9
Baggage -----	50	58	27	4,702	25	50.6	9.2	10.1
Box -----	30	38	20	2,750	18	36	8.5	9
	40	43	22	3,100	20	40.5	8.5	9
	50	43	22	3,100	24	40.5	8.5	9
Caboose -----	---	---	---	---	20	27.5	8.2	7
Diner -----	---	---	---	---	90	78.5	8.5	8.5

Flat -----	40	----	----	----	18	40	9	----
	50	----	----	----	20	45	9	----
	70	----	----	----	25	50	9	----
Gondola -----	50	----	----	1,570	22	40	9.9	4
	70	----	----	1,920	25	48	10	4
Refrigerator -----	^a 30	----	----	2,570	28	40.5	8.2	7.2
	^b 40	----	----	2,570	30	40.5	8.2	7.5
Stock -----	30	----	20	2,625	20	36	8.5	8.5
	40	----	20	3,003	22	40.6	8.6	8.6
Tank -----	^c 40	----	----	----	20	33	^e 6.6	----
	^d 50	----	----	----	24	33	^e 7.2	----

^a Ice capacity, 4 tons.

^b Ice capacity, 5 tons.

^c 8,000 gallons.

^d 10,000 gallons.

^e Diameter.

4-5. Dimensions, Weight, and Capacities of Predominant Types of West German Freight Cars

Type of car	Number of axles	Tare weight (STON)	Capacity		Length	Inside dimensions			Door dimensions		Height of floor above top of rail
			Cubic feet level full	Short tons		Width	Height	Width	Height		
Boxcar, G-10 -----	2	11.4	1,500	16.5	25'11 ¾"	8'	7'4 9/16"	4'11 1/16"	6'6 11/16"	4'1/16"	
Boxcar, GLMHS-50 -----	2	13.4	2,500	23.1	36'9 5/16"	8'11 1/16"	9'5/8"	6'6 11/16"	6'6 11/16"	4'9/16"	
Boxcar, GM-30 -----	2	12.7	1,700	23.1	24'10"	8'10"	31'4"	5'6"	6'	Not available	
Boxcar, GMS-54 -----	2	12.6	2,100	23.1	30'5 11/16"	8'8 11/16"	8'9 ½"	5'10 13/16"	6'7 ⅛"	4'1/16"	
Boxcar, KMMKS-51 -----	2	12.5	1,420	30.8	28'8 13/10"	9'5/8"	5'6 ⅙"	5'10 13/16"	4'10 5/8"	4'1 7/16"	
Boxcar, KMM8KS-58 -----	2	14.3	1,800	29.7	28'8 9/16"	8'11 1/16"	7'1 5/16"	12'8 ¾"	6'6 11/16"	4'11/16"	
Gondola, X-05 (low side) -----	2	Not available	320	23.1	25'7"	8'7"	1'4"	---	---	Not available	
Gondola, XLM-57 (low side) -----	2	8.4	330	23.1	29'7"	8'6"	1'4"	---	---	4'	
Gondola, OMM-37 (high side) -----	2	9.7	1,210	24.6	27'7"	9'	4'10"	---	---	4'	
Gondola, OMM-52 (high side) -----	2	11.0	1,200	28.6	28'	8'	4'10"	---	---	4'	
Gondola, OMM-55 (high side) -----	2	11.0	1,200	27.5	28'8 9/16"	9'3/8"	4'11 1/16"	5'10 ½"	---	4'7/8"	
Gondola, OMM-53 (high side) -----	2	12.1	1,200	27.5	28'	8'9"	4'10"	---	---	4'	
Gondola, OMM-33 (high side) -----	2	11.5	1,260	27.0	28'7 3/16"	9'7/16"	5'1"	4'11 1/16"	---	4'5/8"	
Flatcar, R-10 ^a -----	2	10.6	---	16.5	33'2 5/16"	8'9"	6'6 11/16"	---	---	4'	
Flatcar, RM-31 ^a -----	2	14.3	---	22.1	34'11 9/16"	8'6 5/16"	6'5/16"	---	---	4'1 ⅙"	
Flatcar, RMM-33 ^a -----	2	11.4	---	27.0	34'8 3/8"	9'2 ¼"	5'5 11/16"	---	---	4'1 ¼"	
Flatcar, RLMMS-56 ^a -----	2	14.0	---	25.3	40'	8'11"	Not available	---	---	4'	
Flatcar, SM-14 ^a -----	2	11.9	---	23.1	41'6"	8'9"	Not available	---	---	Not available	
Flatcar, SS-15 ^a -----	4	21.5	---	40.2	48'2"	8'9"	Not available	---	---	Not available	
Flatcar, SSLMA-44 -----	4	22.7	---	44.1	59'2 7/16"	9'¼"	4'10 ¼"	---	---	4'5 ¾"	
Flatcar, SSLMAS-53 -----	4	26.3	---	61.6	60'8 5/16"	8'11 13/16"	Not available	---	---	4'6 ⅙"	
Flatcar, SSKM-49 -----	4	17.1	---	55.1	40'8 ¾"	8'5 15/16"	Not available	---	---	4'3 9/16"	
Tank car -----	2	14.0	(^b)	---	21'2"	---	---	---	---	5'	
Tank car -----	4	26.4	(^c)	---	33'½"	---	---	---	---	5'	

^a Height of flatcars is determined by height of stanchion.

^b 4,356 U. S. gallons.

^c 14,266 U. S. gallons.

4-6. Dimensions, Weight, and Capacities of Predominant Types of Vietnamese Freight Cars

Type of car	Number of axles	Tare weight (STON)	Capacity		Inside dimensions (meters)			Door dimensions (meters)		Height of floor above top of rail (meters)
			Cubic meters	Pounds	Length	Width	Height	Width	Height	
Boxcar, G -----	2	6.0	22.95	22,045.8	5.414	2.120	2.0	1.45	1.9	1.0
Boxcar, GG -----	4	19.5	66.35	55,144.5	13.118	2.529	2.0	1.829	1.8	1.1
Flatcar, M -----	2	4.9	----	22,045.8	----	----	----	----	----	1.0
Flatcar, MM -----	4	13.0	----	55,144.5	----	----	----	----	----	1.0
Gondola, H -----	2	5.2	12.1	22,045.8	5.47	2.2	1.03	1.45	1.03	1.0
Gondola, HH -----	4	13.65	29.98	55,114.5	11.0	2.5	1.09	1.45	1.09	1.0
Tank car, MR -----	2	5.6	10.0	22,045.8	----	----	----	----	----	1.0
Tank car, MMR -----	4	18.5	30.0	45,908.0	----	----	----	----	----	1.08

4-7. Dimensions, Weight, and Capacities of Predominant Types of Korean Freight Cars

Type of car	Number of axles	Tare weight (STON)	Capacity		Inside dimensions (meters)			Door dimensions (meters)		Height of floor above top of rail (meters)
			Cubic meters	Pounds	Length	Width	Height	Width	Height	
Boxcar -----	4	18.8	58.0	66,000	10.202	2.67	2.10	1.52	1.8 ^a	Not available
Flatcar -----	4	17.0	----	99,000	10.5	3.05	----	----	----	1.2
Gondolas -----	4	12.7	46.64	66,000	10.084	2.643	1.75	----	----	Not available
Tank cars, Juna ----	4	20.5	(^b)	71,962	11.8	2.050	Not available	----	----	Not available

^a Estimated.

^b 9,620 U. S. gallons.

4-8. Capacity of Standard U.S. Passenger Cars

	<i>Day coach</i> ¹	<i>Tourist sleeper</i>	<i>Standard sleeper</i> ²
Length in feet -----	65-75	65-75	65-80
Number of sections -----	None	13-16	12-16
Maximum seating:			
2 men to each double seat -----	60-70	52-64	53-64
3 men to each 2 double seats -----	45-52	39-48	40-48

Sleeping capacity:

	<i>Day coach</i> ¹	<i>Tourist sleeper</i>	<i>Standard sleeper</i> ²
2 men per berth (maximum) -----	None	52-64	53-64
3 men per section -----	None	39-48	36-48
1 man per berth -----	None	26-32	27-32

¹ Limited number of steel coaches, 70 feet long or over, available.

² Standard sleeper—12 sections and 1 drawing room or 16 sections and no drawing room.

Section III. OPERATIONS

4-9. Planning Requirements

In planning for the most effective use of a railway system, detailed information about items *a* through *z* below is essential. FM 55-8 provides additional information on evaluating existing facilities.

- a.* Length of line.
- b.* Condition of roadbed and track.
- c.* Gage of track.
- d.* Single, double, or multiple track.
- e.* Weight of rail.
- f.* Type of ballast and depth.
- g.* Type of ties (if wood, treated or untreated).
- h.* Tie spacing.
- i.* Axle-load limitations (track and bridge).
- j.* Profile of line showing location and length of ruling grade.
- k.* Alinement of lines showing location and length of minimum-radius curves.
- l.* Location and description of bridges and tunnels.
- m.* Location and length of passing tracks.
- n.* Location, type, and quantity of fuel supply.
- o.* Location, quantity, and quality of water supply.
- p.* Location and capacity of yards.
- q.* Location and capacity of car repair shops and enginehouses.

r. Type and availability of motive power (weight in working order, expected working tractive effort, drawbar pull, and age).

s. Type and availability of rolling stock (capacity, dimensions, and age).

t. Climatic and prevailing weather conditions.

u. Diagrams showing minimum structure, maximum unrestricted loading, and equipment gages.

v. Signal system (wire or radio requirements and coordinating responsibilities).

w. Dispatching facilities.

x. Route junctions.

y. Availability of new equipment and repair parts.

z. Local labor resources.

4-10. Outline of Standing Operating Procedure for Rail Movements

a. General. Policies and factors involved in selecting and accomplishing movements via rail.

b. Supply Movements.

(1) *Releases.* When required, methods of obtaining, formats, dissemination, action required.

(2) *Routing.* Responsibilities and procedures for determination, coordination, and accomplishment.

(3) *Diversions and reconsignments.* Authority and initiating procedures for; method of execution.

(4) *Records and reports.* Responsibilities and methods for the maintenance of specific records; appropriate references to reports to be submitted.

c. Personnel Movements—Troops.

(1) *Military authorization identification numbers (MAIN).* Purposes, composition, methods, and procedures for assignment and use; marking on and eradicating from trains.

(2) *Halts.* Types; policies, procedures, and responsibilities for establishment and conduct.

(3) *Travel warrants.* Types, forms, authority, and responsibilities for issue, distribution, and usage.

(4) *Troop-train commanders.* Appointment, responsibilities, and functions; relationship with transportation personnel; instructions to be furnished.

(5) *Rations and water.* Responsibilities and procedures for securing, furnishing en route, and disposition at destination.

(6) *Discipline of troops.* Responsibilities and command policies, police of rail equipment, sanitation.

(7) *Diversions.* Authority for ordering, responsibilities and procedures for effecting, reference to reporting.

(8) *Records and reports.* Responsibilities and methods for the maintenance of specific records and appropriate references to reports to be submitted.

4-11. Outline of Standing Operating Procedure for Transportation Railway Service

a. General. Policies and procedures for—

(1) Integration of rail transportation in the theater transportation net.

(2) Operational control.

(3) Coordination with adjacent commands for use of rail capacity and support of operating units.

(4) Coordination of the theater rail plan for selection, rehabilitation, and operation or rail lines in support of theater strategic plans.

b. Mission. Rail net and facilities operated; terminals, installations, and commands supported.

c. Organization. Operating units available, location, and operating limits.

d. Functions. Responsibilities for operation and maintenance of military railways, equipment, and freight, passenger, and special trains.

e. Planning.

(1) Long-range planning responsibility and procedures; selection of rail primary and alternate routes; determination of line capacity, troop equipment, and supply requirements; rehabilitation and project requirements; communications and security requirements; demolition plans.

(2) Current operational plans; current rail line capacity and requirements; phases of operation; selection and rehabilitation of new or additional railheads, yards, and installation facilities.

f. Operations. Procedures for dissemination and implementation of movement programs; coordination with transportation movements officer; priorities for and utilization of rail equipment; responsibilities for preparation and compilation of operational and situation reports; procedures for ordering and documentation of cars; responsibilities for scheduling special trains; construction and use of rail car spanners, responsibility and methods of loading, blocking, bracing, and inspecting loaded cars.

g. Maintenance. Responsibility, procedures, inspections, reports, and standards for maintenance of military and utility railway facilities and equipment, including organizational, field, and depot maintenance.

h. Supply. Responsibility and procedures for requisitioning, stocking, distributing, maintaining levels of, disposing of excess, and accounting for railway operating and maintenance supplies; requirements and priorities for major items, including locomotives and rolling stock.

i. Intelligence and Reconnaissance. Responsibility and procedures for collecting, processing, disseminating, and using intelligence.

j. Security. Procedures, responsibility, coordination, and requirements for security of supplies en route by rail and security of trains and rail line-of-communication facilities; defense and demolition plans.

k. Records and Reports. Responsibility and procedures for reports; railway operation, situation, personnel status, equipment maintenance and inspection, equipment status, and project.

l. Training. Responsibility for conducting unit and technical training.

4-12. Maximum Bulk Loading of Typical U.S. Freight Cars

The rated weight capacity of a car does not mean that the car can carry the rated tonnage of all items. For many types of cargo, the cubic capacity of the car is reached ahead of the rated capacity. When this occurs, the tonnage that the car can carry represents its actual capacity.

a. High Density Items. Freight cars loaded with high density items can nearly always be loaded to their rated capacity. Examples of high density items are ammunition, barbed wire, cement, flour, gravel, corrugated iron, rails, rifles in chests, sand, stone, sugar, telephone wire, and engineer tools.

b. Lighter Bulk Items. Some items for which the cubic capacity of the car is reached at the time of or before the rated tonnage has been loaded are listed below.

	Car capacity in short tons		
Rated	30	40	50
Actual, by items:			
Blankets, baled	27	32	40

	Car capacity in short tons		
Bread	19	24	30
Canned goods in boxes	30	36	45
Clothing, baled	27	32	40
Meat	15	24	35
Motor vehicle parts	24	28	40
Sandbags	21	24	30
Tentage	15	20	30
Ties, railroad	19	26	32

4-13. Clearances—General

Overhead clearances and platform heights are measured from top of rail; side clearances from centerline of track. Clearances below those specified are dangerous, and protection must be provided by appropriate warning signs or devices. For example, telldales must be used for overhead clearances ranging between 18 to 22 feet. Unless local conditions require greater clearances, the standard minimum clearances are as follows:

	Meters	Feet and inches
<i>a. Overhead.</i>		
Wires:		
High voltage	8.53	28' 0"
Other	8.23	27' 0"
Structures	6.71	22' 0"
<i>b. Side.</i>		
Buildings	2.59	8' 6"
Canopies:		
Up to 15' 6"	2.59	8' 6"
Higher than 15' 6"	1.68	5' 6"
Platforms:		
3' 9"	1.88	6' 2"
4'	1.52	5' 0"
Refrigerator platforms:		
3' 2"	1.88	6' 2"
4' 7"	2.59	8' 6"
<i>c. Engine-house Entrance.</i>		
Overhead	5.18	17' 0"
Side	1.98	6' 6"

d. Bridge and Tunnel. Standard single-track bridge and tunnel clearances are shown in figure 4-2.

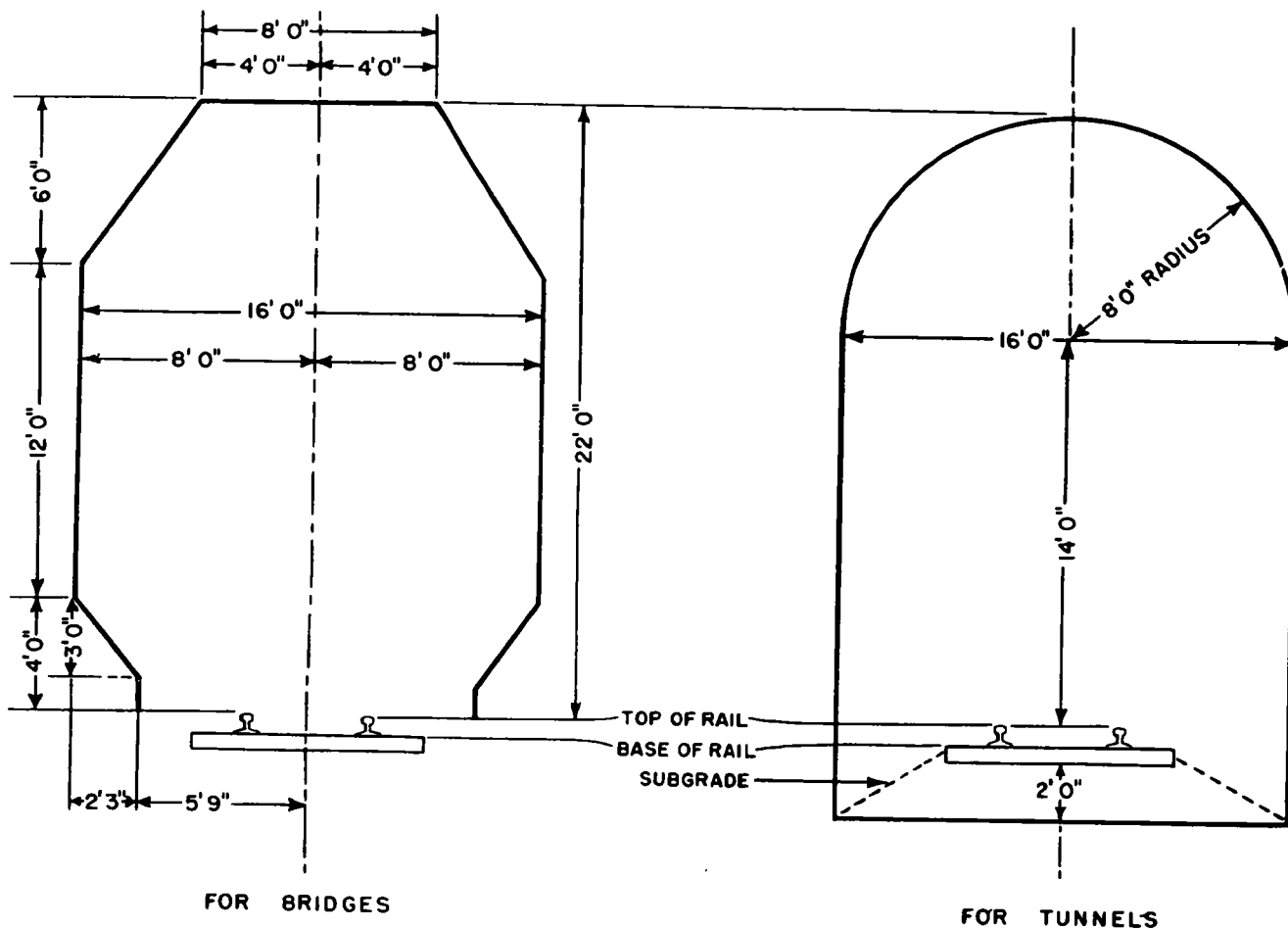


Figure 4-2. Standard single-track bridge and tunnel clearances.

4-14. Railway Gages (in inches) by Area

Gages	23 3/8	24	29 1/2	30	35	36	37	37 3/8	37 7/16	39 3/8	40	41 1/4	41 1/2	41 9/16	42	50 3/8	50 7/8	5 1/8	60	63	66
<i>a. Africa.</i>																					
Algeria	--	--	--	--	--	--	--	--	--	X	--	--	--	X	--	X	--	X	--	--	--
Cameroun	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
Central African Republic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
Chad	--	--	--	--	--	--	--	--	X	--	--	--	--	--	X						
Congo, Republic of (Brazzaville)	--	X	--	--	--	--	--	--	--	X	--	--	--	--	X						
Congo, Republic of (Leopoldville)	--	X	--	--	--	--	--	--	--	X	--	--	--	--	X						
Dahomey	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
Egypt	--	--	X	X	--	--	--	--	--	X	--	--	--	--	--	X					
Ethiopia	--	--	--	--	--	--	--	--	--	X											
Gabon	--	--	--	--	--	--	--	--	--	X	--	--	--	--	X						
Ghana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
Guinea	--	--	--	X																	
Ivory Coast	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X						
Kenya	--	--	--	--	--	--	--	--	--	X											
Liberia	--	--	--	X																	
Libya	--	--	--	--	--	--	X	--	X	--											
Malagasy	--	--	--	--	--	--	--	--	--	X											
Mali	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X					
Mauritania	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	X					
Morocco	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X					
Niger	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	X					
Nigeria	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X						
Nyasaland	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
Portuguese East Africa (Mozambique)	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X						
Portuguese West Africa (Angola)	--	X	--	--	--	--	--	--	--	X	--	--	--	--	X						
Republic of South Africa	--	X	--	--	--	--	--	--	--	--	--	--	--	--	X						
Réunion	--	--	--	--	--	--	--	--	--	X											
Rhodesia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
Senegal	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X					
Sierra Leone	--	--	--	X																	
Somalia	--	--	--	--	--	--	--	--	--	X											
Sudan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						

Gages	23 $\frac{5}{8}$	24	29 $\frac{1}{2}$	30	35	36	37	37 $\frac{5}{8}$	37 7/16	39 $\frac{3}{8}$	40	41 $\frac{1}{4}$	41 $\frac{1}{2}$	41 9/16	42	50 $\frac{1}{2}$	56 $\frac{5}{8}$	5 $\frac{1}{8}$	60	63	66
Swaziland	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
Tanzania	--	--	--	--	--	--	--	--	--	X											
Togo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
Tunisia	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	X					
Uganda	--	--	--	--	--	--	--	--	--	X											
Upper Volta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X					
Zambia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X						
<i>b. Asia.</i>																					
Afghanistan	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	X	--	--	X	--	--
Borneo	--	--	--	--	--	--	--	--	--	X											
Burma	--	--	--	--	--	--	--	--	--	X											
Cambodia	--	--	--	--	--	--	--	--	--	X											
Ceylon	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
China	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Formosa	--	X	--	X	--	--	--	--	--	--	--	--	--	--	--	X					
India	--	X	--	X	--	--	--	--	--	X	--	--	--	X							
Indonesia	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Iran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X				
Iraq	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	X	--	--	X	--	--
Israel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X					
Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X				
Jordan	--	--	--	--	--	--	--	--	--	--	--	X									
Korea	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	X					
Laos	--	--	--	--	--	--	--	--	--	X											
Lebanon	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	X					
Malaya	--	--	--	--	--	--	--	--	--	X											
Nepal	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X
Pakistan	--	--	--	--	--	--	--	--	--	X	X	--	--	--	--	--	--	--	--	--	X
Saudi Arabia	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	X					
Syria	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	X					
Thailand	--	--	--	--	--	--	--	--	--	X											
Tibet	--	--	--	--	--	--	--	--	--	X											
Turkey	--	--	X	--	--	--	--	--	--	X	--	--	X	--	--	X	--	--	X		
U.S.S.R.	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	X		
Vietnam	--	--	--	--	--	--	--	--	--	X									X		
<i>c. Europe.</i>																					
Albania	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	X					

Gages	23 5/8	24	29 1/2	30	35	36	37	37 5/8	37 7/16	39 3/8	40	41 1/4	41 1/2	41 9/16	42	50 1/2	50 5/8	51 1/8	60	63	66
Panama	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--
Puerto Rico	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--
Trinidad	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
<i>e. North America.</i>																					
Canada	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
Newfoundland	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--
Mexico	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
United States (CONUS) ..	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
Alaska	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
Hawaii (see Pacific Ocean)																					
<i>f. South America.</i>																					
Argentina	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--	X	--	--	--	--	X
Bolivia	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--
Brazil	--	X	--	X	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X
British Guiana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
Chile	--	X	--	X	--	--	--	--	--	X	--	--	--	--	X	X	--	--	--	--	X
Colombia	--	--	--	--	--	X	--	--	--	X	--	--	--	--	X	X	--	--	--	--	--
Dutch Guiana	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--
Ecuador	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--
Paraguay	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
Peru	--	--	--	--	--	X	--	--	--	X	--	--	--	--	--	X	--	--	--	--	--
Uruguay	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
Venezuela	--	X	--	X	--	X	--	--	--	X	--	--	--	--	X	X	--	--	--	--	--
<i>g. Pacific Ocean.</i>																					
Australia	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X	X	--	--	--	--	X
Hawaii	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
New Caledonia	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--
New Zealand	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--
Philippines	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--
Tasmania	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--

4-15. Clearances and Gages

The sample clearance diagrams shown in figures 4-3 and 4-4 refer to the distance that equipment or cargo may project to the side at various heights above track level. They are composites incorporating the smallest dimensions of all similar dimensions of the countries having the gages shown (para 4-4); therefore, not all the limiting clearances shown in the composites will exist simultaneously on any particular rail line. A clearance diagram

for the rail line(s) over which operations are to be conducted must be obtained or made. Horizontal distances shown in the diagrams should not be confused with the track gage. The composite clearances in figure 4-3 show minimum clearances for the standard-gage (56½-inch), and for the broad-gage track indicated. Figure 4-4 shows clearances for three sizes of narrow-gage track. Examples of the use of the diagrams are given below.

a. In figure 4-3, a vertical clearance of 3

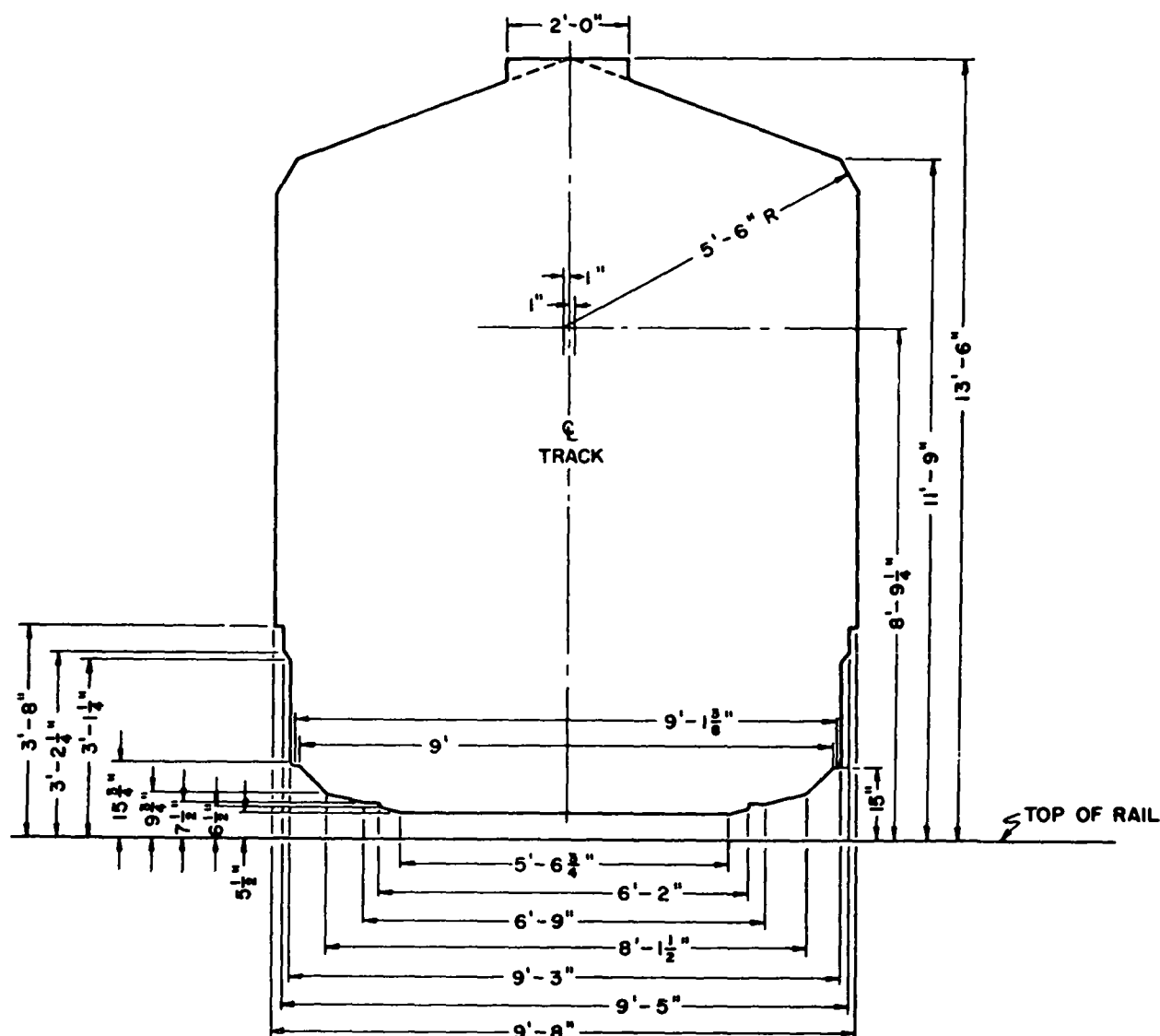


Figure 4-3. A composite clearance diagram: 56½-, 60-, 63-, and 66-inch gages.

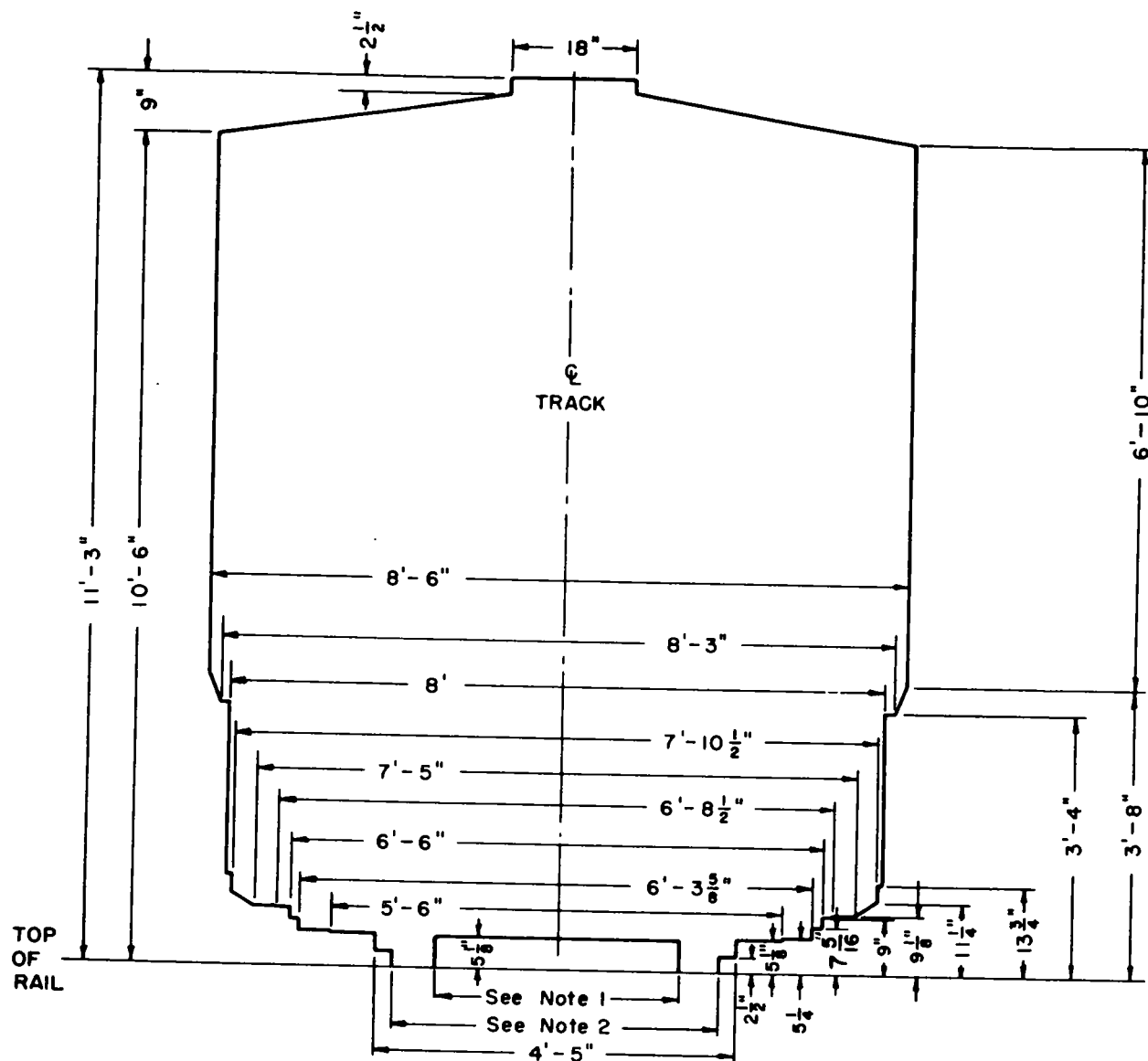


Figure 4-4. A composite clearance diagram: 36-, 39 3/8-, and 42-inch gages.

feet 8 inches can be depended upon for a width clearance which is at least 9 feet 8 inches. In the same figure, a vertical clearance of 9 3/4 inches can be depended upon if the width clearance is not less than 8 feet 1 1/2 inches.

b. In figure 4-4, a vertical clearance between

13 3/4 inches and 3 feet 4 inches can be depended upon when the width clearance is not less than 8 feet.

4-16. Bridge Capacity

a. *Cooper's E Rating.* This figure indicates, in thousands of pounds, the weight a bridge

can support for each driving axle of a locomotive. Military railroad bridges are normally designed for Cooper's E-45 but may be built for lighter or heavier loadings as required. For example, the following method is used to determine the rating a bridge must have if it is to be crossed safely by a 2-8-0 locomotive weighing 140,000 pounds on drivers:

A 2-8-0 locomotive has four driving axles.

140,000 pounds (weight of locomotive) divided by 4 (number of driving axles) equals 35,000 pounds (weight per driving axle). Therefore, any bridge which has a rating of E-35 or above can be crossed safely by this locomotive.

b. Steel I-Beam Bridge (fig. 4-5). The table below refers to bridges already constructed with two, four, six or more steel stringers or girders of equal dimensions. To estimate the capacity of a railway bridge with this type of construction, the width and thickness of the lower flange of one stringer are measured at

the center of the span length; the depth and length of the stringer are also measured. Using the table below, the steel stringer that is nearest to these dimensions is selected, and the corresponding E-rating of the bridge is read. The rating is reduced according to the age and condition of the bridge. The quantity of reduction must be determined by qualified personnel, normally from the Corps of Engineers. For additional information concerning bridge capacities, refer to TM 5-312.

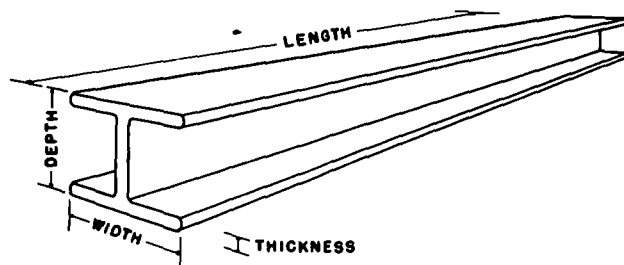


Figure 4-5. Measuring a steel stringer.

Stringer dimensions (in.)

Lower flange													
Thickness	Width	Stringer depth	10	11	12	13	14	15	16	17	18	19	20
$\frac{3}{8}$	8 $\frac{3}{8}$	18	E-42	E-41	E-41	E-41							
$\frac{3}{8}$	10 $\frac{3}{8}$	24	-----	E-59	E-48	E-40	E-35	E-31	E-27				
$\frac{1}{2}$	10 $\frac{3}{8}$	30	-----	-----	-----	E-61	E-59	E-51	E-46	E-41	E-37	E-33	E-30
$\frac{1}{2}$	12 $\frac{1}{2}$	30	-----	-----	-----	-----	-----	E-62	E-56	E-50	E-45	E-41	E-37
1	14	36	-----	-----	-----	-----	-----	-----	-----	E-60	E-58	E-55	E-54
$\frac{1}{2}$	12 $\frac{3}{8}$	42	-----	-----	-----	-----	-----	-----	-----	-----	-----	E-60	E-54
1 $\frac{1}{8}$	14	42	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	E-63
1 $\frac{1}{8}$	16	42	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1 $\frac{1}{2}$	16	48	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1	16	48	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1 $\frac{3}{8}$	14	54	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1 $\frac{3}{8}$	14	60	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1 $\frac{1}{2}$	14	60	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2 $\frac{1}{8}$	15	66	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2	14	66	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2	14	72	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2 $\frac{1}{2}$	15 $\frac{1}{2}$	72	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2 $\frac{1}{8}$	14	78	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2 $\frac{1}{2}$	16	84	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2 11/16	20	96	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Note. This chart presents type data for determination of order of magnitude. One per rail is assumed. Qualified personnel from the

c. *Wooden Bridge* (fig. 4-6). For a bridge with wooden stringers, the width of each stringer is measured under one track at the center of the length span and added to obtain total stringer width. In figure 4.6, the total

stringer width is 2 x W. The depth and length of one stringer are also measured. The following table is used with the same procedures as the table in b above.

Stringer dimensions (in.)		Span length (ft)							
Width	Depth	10	12	14	16	18	20	22	
18	12	E-16	E-12						
18	14	E-22	E-18	E-10					
18	16	E-28	E-20	E-15	E-10				
18	18	E-38	E-26	E-18	E-14	E-12			
20	12	E-18	E-12						
20	14	E-25	E-17	E-12					
20	16	E-33	E-23	E-16	E-12	E-10			
20	18	E-43	E-29	E-21	E-16	E-13	E-10		
24	12	E-22	E-15	E-11					
24	14	E-30	E-21	E-14	E-11				
24	16	E-40	E-28	E-20	E-15	E-12			
24	18	E-52	E-36	E-25	E-19	E-15	E-12	E-10	
36	12	E-34	E-23	E-17	E-12	E-10			
36	14	E-47	E-32	E-23	E-17	E-14	E-11		
36	16	E-62	E-43	E-30	E-23	E-19	E-15		
36	18	E-78	E-53	E-30	E-30	E-24	E-20	E-16	
40	12	E-38	E-26	E-19	E-14	E-11			
40	14	E-52	E-36	E-26	E-20	E-16	E-12		
40	16	E-69	E-47	E-35	E-26	E-21	E-17		
40	18	E-87	E-60	E-44	E-34	E-27	E-22	E-18	
48	12	E-46	E-31	E-23	E-17	E-13			

Span length (ft)

22 24 26 28 30 35 40 44 50 54 60 64 70 74 80 84 90

E-27																	
E-31	E-26																
E-51	E-48	E-43	E-39	E-34	E-26												
E-45	E-39	E-34	E-30	E-26													
E-60	E-57	E-54	E-51	E-45													
			E-60	E-54	E-42	E-32											
				E-59	E-52	E-47	E-43	E-33									
			E-66	E-57	E-45	E-35	E-30										
					E-54	E-43	E-36	E-28									
						E-60	E-54	E-43	E-37	E-30	E-27						
						E-57	E-48	E-38	E-33	E-27							
								E-57	E-54	E-46	E-41	E-34	E-31	E-26			
								E-56	E-48	E-40	E-35	E-30	E-26				
								E-62	E-54	E-44	E-39	E-32	E-29	E-25			
										E-55	E-51	E-43	E-38	E-33	E-29		
									E-64	E-52	E-46	E-39	E-35	E-30			
											E-64	E-54	E-49	E-41	E-38	E-30	
															E-59	E-51	

Corps of Engineers should be consulted for bridge capacity.

Stringer dimensions
(in.)

Span length (ft)

Width	Depth	10	12	14	16	18	20	22
48	14	E-63	E-43	E-31	E-24	E-19	E-15	
48	16	E-83	E-57	E-41	E-32	E-26	E-21	
48	18	E-105	E-73	E-53	E-41	E-33	E-27	E-22
54	12	E-52	E-35	E-27	E-19	E-15		
54	14	E-72	E-49	E-35	E-22	E-18		
54	16	E-94	E-65	E-46	E-36	E-29	E-24	
54	18	E-119	E-82	E-60	E-46	E-38	E-30	E-25
60	12	E-58	E-40	E-30	E-22	E-17		
60	14	E-79	E-55	E-39	E-30	E-35	E-20	
60	16	E-104	E-72	E-52	E-40	E-33	E-27	
60	18	E-132	E-92	E-67	E-52	E-42	E-34	E-28

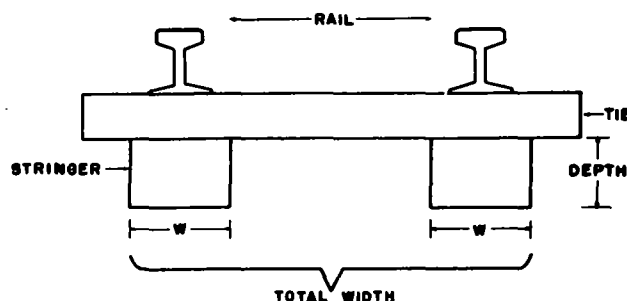


Figure 4-6. Measuring a wooden stringer.

4-17. Loading Open-Top Cars

Military equipment loaded on U.S. Army cars traveling over the lines of common carriers and on cars belonging to common carriers within the continental United States must meet the loading standards of the individual railroad and those of the Association of American Railroads (AAR). Cars loaded on foreign lines should meet the blocking and lashing standards of the area involved. The standards for and methods of blocking, nailing, and bracing for some typical military loadings are

given in this paragraph. Association of American Railroads (AAR) regulations, *Rules Governing the Loading of Department of Defense Material on Open-Top Cars*, should be followed. The following examples apply only to the loading of flatcars and composite gondolas with wooden floors with the equipment listed in *a* through *d* below and illustrated in figures 4-7 through 4-11. The letters in the item column refer to the letters shown in the illustrations. In all examples, brake wheels have the clearances shown in figure 4-12. The various wooden blocks, cut to specific patterns and numbered, are illustrated in figure 4-13. Additional details are contained in TM 55-601.

a. Six-Wheel Truck (fig. 4-7).¹

Item	No. of pieces	Description
A	-----	Brake-wheel clearance (fig. 4-12).
B	8 -----	Blocks, pattern 16 (fig. 4-13). Locate 45° portion of block against front and rear of front wheels, in front of outside intermediate wheels, and back of outside rear wheels. Secure heel of block to floor with three 40-d nails and toenail that portion under tire to floor with two 40-d nails before items D and E are applied. Substitute, if desired, at each location, blocks, pattern 17 (fig. 4-13), or blocks, pattern 18 (fig. 4-13).
C	8 -----	2 by 4 inches. Locate against block pattern 18 (fig. 4-13) lengthwise of car, and secure to floor with four 30-d nails. Not required when blocks, pattern 16 (fig. 4-13) and 17 (fig. 4-13), are used.
D	1 each outside wheel.	Suitable material, such as waterproof paper, burlap, etc. Locate bottom portion under items E, top portion to extend 2 inches above items E.
E	6 -----	Each consisting of 2 pieces of wood 2 by 4 by 36 inches. Secure lower piece to floor with four 30-d nails and top piece to one below in like manner.
F	2 each axle--	At each location use four strands of No. 8 gage, black annealed wire. Pass over axle,

Item	No. of pieces	Description
		springs, spring shackles, underneath and around item G and twist taut after item G has been nailed in place. 1-inch bolts (2 for each axle), made from 1-inch steel rods threaded at each end, may be substituted. Each bolt is secured on the axle with a steel plate having two holes, a lock-washer, and a 1-inch square nut. The steel plate, with the curved portion of the bolt threaded through the holes, rests under the axle. The bolt passes through the floor of the car then through a 2- by 4- by 18- inch piece of hardwood, and is secured with a flat washer and 1-inch square nut.

Item	No. of pieces	Description
G	1 each item F -----	2 by 4 by 18 inches. Secure to floor, lengthwise of car, with four 30-d nails. Not required when steel straps are used, pattern 19 (fig. 4-13).
H	4 each unit	Four strands of No. 8 gage, black annealed wire. Attach to each corner of machine and to stake pockets. Not required for units loaded in gondola cars.

¹ See notes at end of *d* below.

b. Lighter, Amphibious, 5-ton (LARC-V) (fig. 4-8).

Item	No. of pieces	Description
A	-----	Brake-wheel clearance (fig. 4-12).
B	16 -----	Blocks, pattern 18 (fig. 4-13). Locate two in front and two in rear of each of the four wheels, and secure to floor with two 60-d nails in the heel of block and two 40-d nails in each side of block.
C	4 -----	Rub rail assemblies, see sketch A (fig. 4-8). Nail 2- by 8- by 36-inch vertical member to the lower piece of 2- by 4- by 36-inch lumber with five 12-d nails. Position this assembly with 2- by 8-inch lumber against tire and secure to floor of car through 2- by 4-inch piece with five 20-d

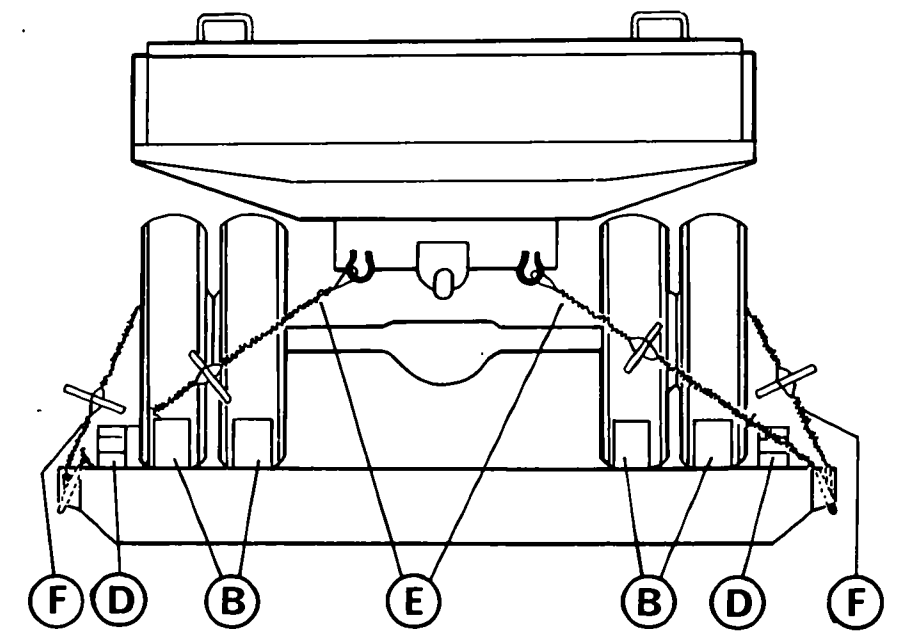
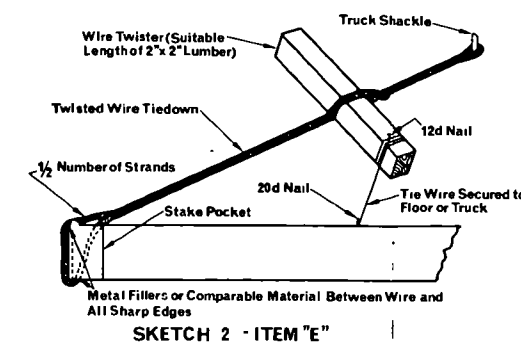
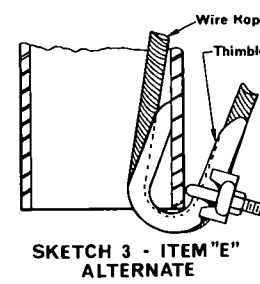
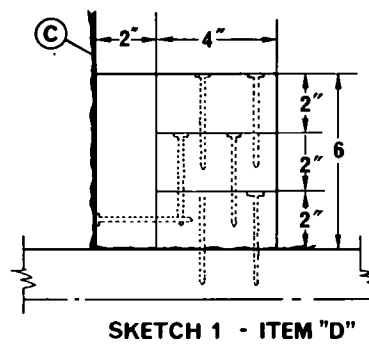
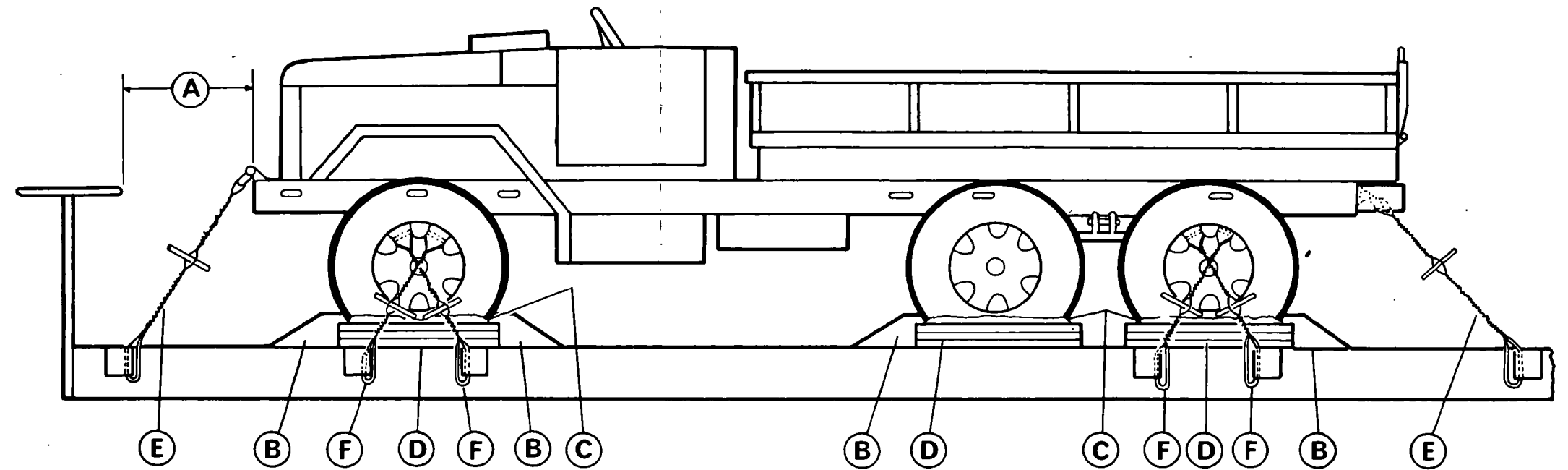


Figure 4-7. Loading a six-wheel truck on an open-top car.

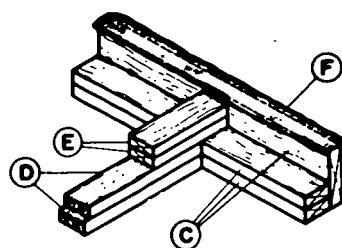
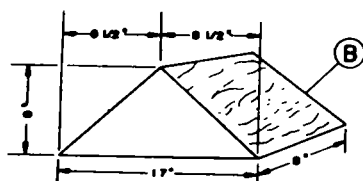
Item	No. of pieces	Description	Item	No. of pieces	Description
		nails. Secure second 2- by 4- by 36-inch piece of lumber to the lower 2- by 4-inch piece with five 20-d nails.			at front and rear wheels. Secure heel of block to floor with three 40-d nails and toenail that portion under tire to floor with two 40-d nails before items C are applied.
D	2	Each to consist of two pieces of 2- by 4-inch lumber, length equal to distance between items C. Secure lower piece to floor with 20-d nails spaced 8 inches apart. Nail top piece to lower piece in like manner.	C	2	Each consisting of 2 pieces of lumber 2 by 4 by 36 inches. Secure lower piece to floor with three 40-d nails and top piece to one below in like manner.
E	4	Two pieces of 2- by 4- x 24-inch lumber. Nail to items C and D, using eight 20-d nails to each piece.	D	2	Support, pattern 62 (fig. 4-13), length $\frac{1}{4}$ -inch longer than the distance between point of support on gun carriage and floor. Place between floor and gun carriage to partially relieve weight on tires. Secure each to floor with six 40-d nails.
F	4	Suitable protective material between tires and rub rail assemblies.	E	2	Four strands of No. 8 gage, black annealed wire. Pass through holes in wheels and secure to stake pockets.
G	6	5/8-inch diameter cable, 6 by 19, improved plow steel with IWRC. Form complete loop with 14-inch overlap.	F	2 for single spade, 4 for double spade.	6 by 8 by 24 inches, cut to fit contour of spade. Locate in front and rear of spade. Toenail to floor with five 40-d nails.
H	4	Same as item G, except with 26-inch overlap. See sketch B (fig. 4-8) for fittings.	G	2 each item F	Each consisting of 2 pieces of lumber 2 by 4 by 12 inches. Secure lower piece to floor, against item F, with three 40-d nails and top piece to one below in like manner.
J	3	Shackles. For vehicles having a 1 1/16-inch diameter hole in the towing bracket, use a 1-inch diameter pin with a 7/8-inch steel galvanized coated anchor shackle. For vehicles having a larger hole in the towing bracket, use an appropriate size pin and shackle. Attach the shackle to the towing bracket and secure the pin with a cotter key.	H	2	2 by 4 by 12 inches. Locate against each side of spade and secure to floor with three 40-d nails.
K	4	2- by 4- by 14 1/2-inch wood protective spacer between cable and side of vehicle. Secure to cable with staples.	J	1 pair	Stakes or green saplings. Locate one-third of distance from end of gun trail to center of wheels.
L	4	Rubber hose protective spacer, 15 inches long.	K	1	Six strands, No. 8 gage, black annealed wire. Loop around and over top of rear end of gun trail and secure to opposite stake pockets. Substitute, if desired, 2- by .05-inch high-tension bands or 1/2-inch steel cables.
M	64	5/8-inch cable clamp, U-type only.			
N	6	5/8-inch closed thimble at load end of bow and stern cables.			
O	10	5/8-inch open thimble. See figure 4-8 for side view of blocking and tiedowns.			

c. Mounted Gun or Howitzer (fig. 4-9).^{1,2}

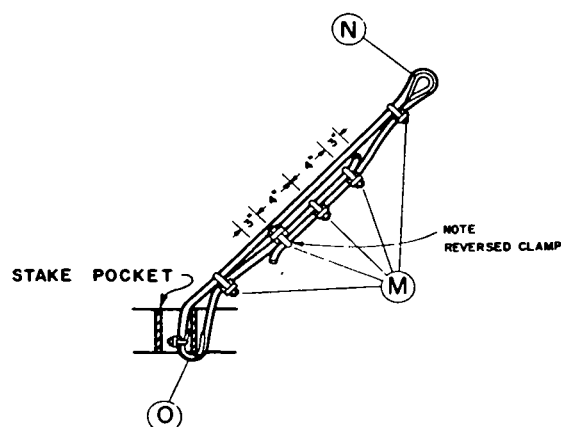
Item	No. of pieces	Description
A	-----	Brake-wheel clearance (fig. 4-12).
B	4	Blocks, pattern 16 (fig. 4-13). Locate 45° portion of block

^{1,2} See notes at end of d below.

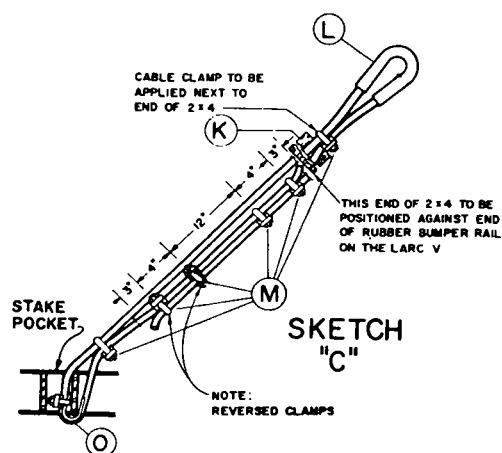
d. Tanks and Similar Units, From 60,000 to 100,000 Pounds (fig. 4-10).^{1,2}



SKETCH "A"



SKETCH "B"



SKETCH "C"

Sketch details.

Figure 4-8. Blocking and tiedowns.

Item	No. of pieces	Description	Item	No. of pieces	Description
A	-----	Brake-wheel clearance (fig. 4-12).			
B	2 -----	Blocks, pattern 31 (fig. 4-13). Locate one against each rear crawler tread.			Locate on floor against inside of each crawler tread, and secure lower piece to floor with twelve 30-d nails and top piece to one below in like manner.
C	2 -----	Blocks, pattern 30 (fig. 4-13). Locate one against each front crawler tread.	G	3 each unit--	Each consisting of 2 pieces of lumber 2 by 4 inches long enough to fill space between items F. Locate one near center and one near each end of items F. Secure lower piece to floor with four 30-d nails and top piece to one below in like manner.
D	1 each items B and C.	2 by 4 by 20 inches. Locate one on inside of items B and C and secure to floor with six 20-d nails.	H	6 -----	Each consisting on 2 pieces of lumber 6 by 6 inches, length to suit, cut to fit contour of bogie wheels. Locate one piece between inside and outside wheels of each bogie assembly.
E	2 each items B and C.	Each consisting of 2 pieces of lumber 2 by 4 by 12 inches. Locate against ends of items B and C. Secure lower piece to floor with four 20-d nails and top piece to one below in like manner.			
F	2 each unit--	Each consisting of 2 pieces of lumber 2 by 4 by 14 inches.			

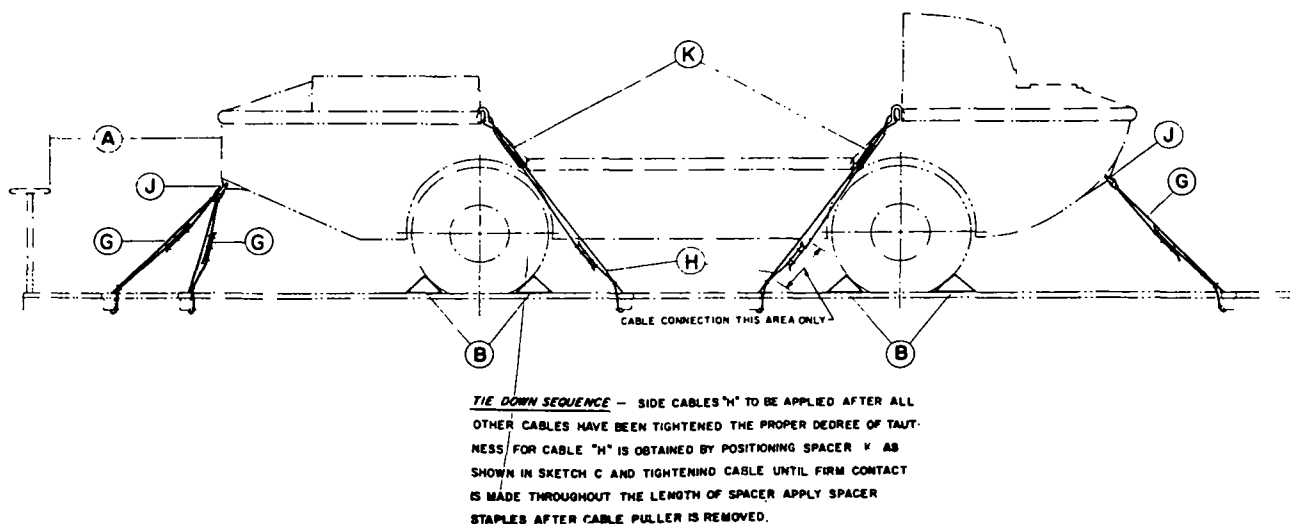
Item	No. of pieces	Description
J	6 -----	Each consisting of 2 pieces of lumber 4 by 4 inches, length to suit. Locate against bogie wheels on top of item H.
K	6 -----	Each consisting of 2 pieces of lumber 4 by 4 inches, long enough to fill space between items H. Toenail each to items H with two 20-d nails.
L	12 -----	Each consisting of two strands No. 8 gage, black annealed wire. Pass under crawler tread and around items H and J. Substitute, if desired, at each location, one ¾-by .035-inch high-tension band. Use staples or nails bent over to retain bands or wires in position.
M	4 -----	1½-inch-diameter rods. Attach to lifting lugs and pass through stake pockets and ½-by 4-by 10-inch plates underneath stake pockets on opposite sides of car. Substitute, if desired, ¾-inch steel cable, doubled.

¹ Set handbrake and wire, or block, lever. When tiedown rods are found slightly loose in transit, they need not be tightened.

² Place turret gun in straight forward position, and wire turret-lockhandwheel and elevating-mechanism handwheel to prevent rotating. When unit is not equipped with built-in gun brace, apply two ¾-inch high-tension bands, securing gun barrel to unit at each side. Rock a tracked vehicle forward and backward under its own power to take the slack out of the tracks and thus secure the vehicle to the blocks.

e. Tanks and Similar Units, 100,000 Pounds and Over (fig. 4-11).

Item	No. of pieces	Description
A	-----	Brake-wheel clearance (see fig. 4-12).
B	2 -----	10 inches by 18 inches by 24 feet. Locate, as shown along each side of car. Secure each to car with at least five bolts 1 inch in diameter passed through items B and C, wood filler in stake pocket, and ½-by 4-by 10-inch plate underneath stake pocket. Not required for units loaded on floor of car.
C	As required -	Metal filler, length, width, and thickness to suit. Locate between items B and top of stake pockets. Not required when units are loaded on floor of car.
D	4 -----	Each to consist of two pieces of lumber 2 by 6 by 18 inches. Locate against item B, as shown. Secure lower piece to floor with four 3-d nails, and top piece to one below in like manner. Not required for units loaded on floor of car.
E	2 -----	Blocks, pattern 30. Locate one against each front crawler tread.
F	2 -----	Blocks, pattern 31. Locate one against each rear crawler tread.



Side view.

Figure 4-8—Continued.

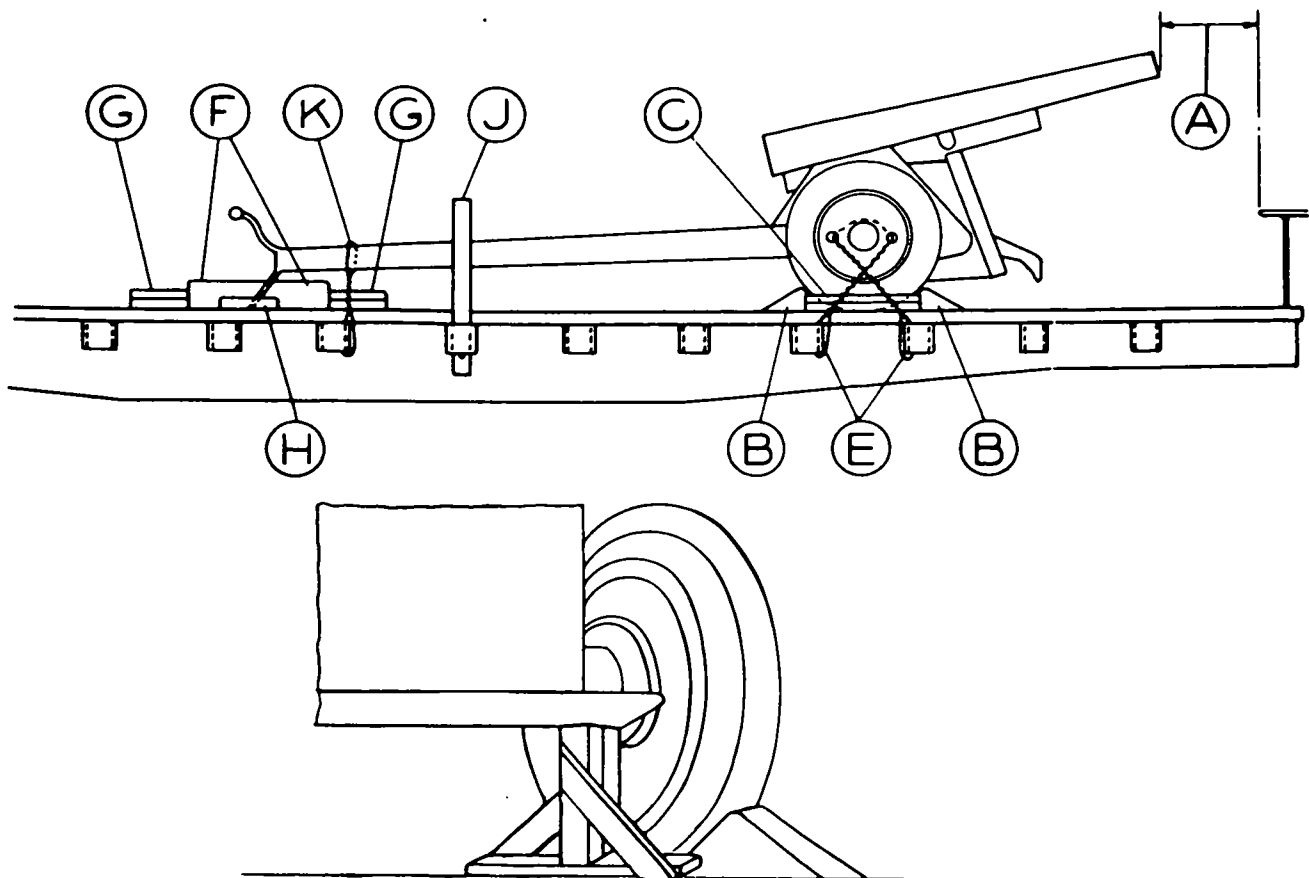


Figure 4-9. Loading a 37mm to 105mm mounted gun or howitzer on an open-top car.

Item	No. of pieces	Description	Item	No. of pieces	Description
G	2 each items E and F.	2 by 3 by 30 inches. Locate as shown against each side of items E and F and secure to floor or item B with four 20-d nails in each.	K	3 -----	4 by 6 inches length equal to distance between items J. Not required for units loaded on floor of car. Substitute, if desired, pattern 80.
H	4 -----	Each to consist of two pieces of lumber 2 by 12 by 18 inches. Locate one against each item E and F. Secure lower piece to floor or item B with five 3-d nails and top piece to one below in like manner. Substitute, if desired, pattern 81 (fig. 4-13).	L	2 -----	Each to consist of two pieces of lumber 2 inches by 4 inches by 14 feet. Locate against inside of crawler treads. Secure lower piece to floor with 30-d nails spaced about 12 inches apart, and top piece to one below in like manner. Required only when units are loaded on floor of car.
J	6 -----	2 by 8 by 13 inches. Locate as shown against items B and crawler, one near each end of unit and one at center. Secure each to item B with four 30-d nails, and to item K with three 30-d nails. Not required for units loaded on floor of car or when pattern 80 (fig. 4-13) is used.	M	3 -----	Each to consist of two pieces of lumber 2 by 4 inches, length to suit, suitably spaced between items L. Secure lower piece to floor with 30-d nails and spaced about 12 inches apart and top piece to one be-

Item	No. of pieces	Description
		low in like manner. Required only when units are loaded on floor of car.
N	As required	Each to consist of two pieces of lumber 6 by 6 inches, length to suit, cut to fit contour of bogie wheels. Locate one piece between inside and outside wheels of each bogie assembly.
O	1 each item N.	2 by 4 inches, length to suit. Locate on top of item N, as shown, and secure with four 20-d nails.
P	8	Rods 1 1/4 inches in diameter. Attach to lifting lugs and pass through stake pockets and 1/2- by 4- by 10-inch plates underneath stake pockets, as shown. Substitute, if desired, 5/8-inch steel cable, doubled.
Q	2	5/8-inch steel cable, doubled. Locate, as shown, between gun turret and crawler structure.

When necessary to extend floor to provide

bearing for wheels or for the application of items G on units loaded on floor of car, apply one piece of blocking on top of stake pockets, long enough to extend beyond wheel chock blocks and high enough to be level with top of floor. Use 1- by 4- by 18-inch lumber at each end of blocking, nail each to floor with three 20-d nails, and to blocking with two 20-d nails.

Turret guns should be in straightforward position and turret lock handwheel and elevating mechanism handwheel must be wired to prevent rotation.

When unit is not equipped with built-in gun brace, apply two 3/4-inch high-tension bands, securing gun barrel to unit at each side.

When tiedown rods are found slightly loose in transit, they need not be tightened.

Handbrake must be set and levers wired or blocked.

See General AAR rules for further details.

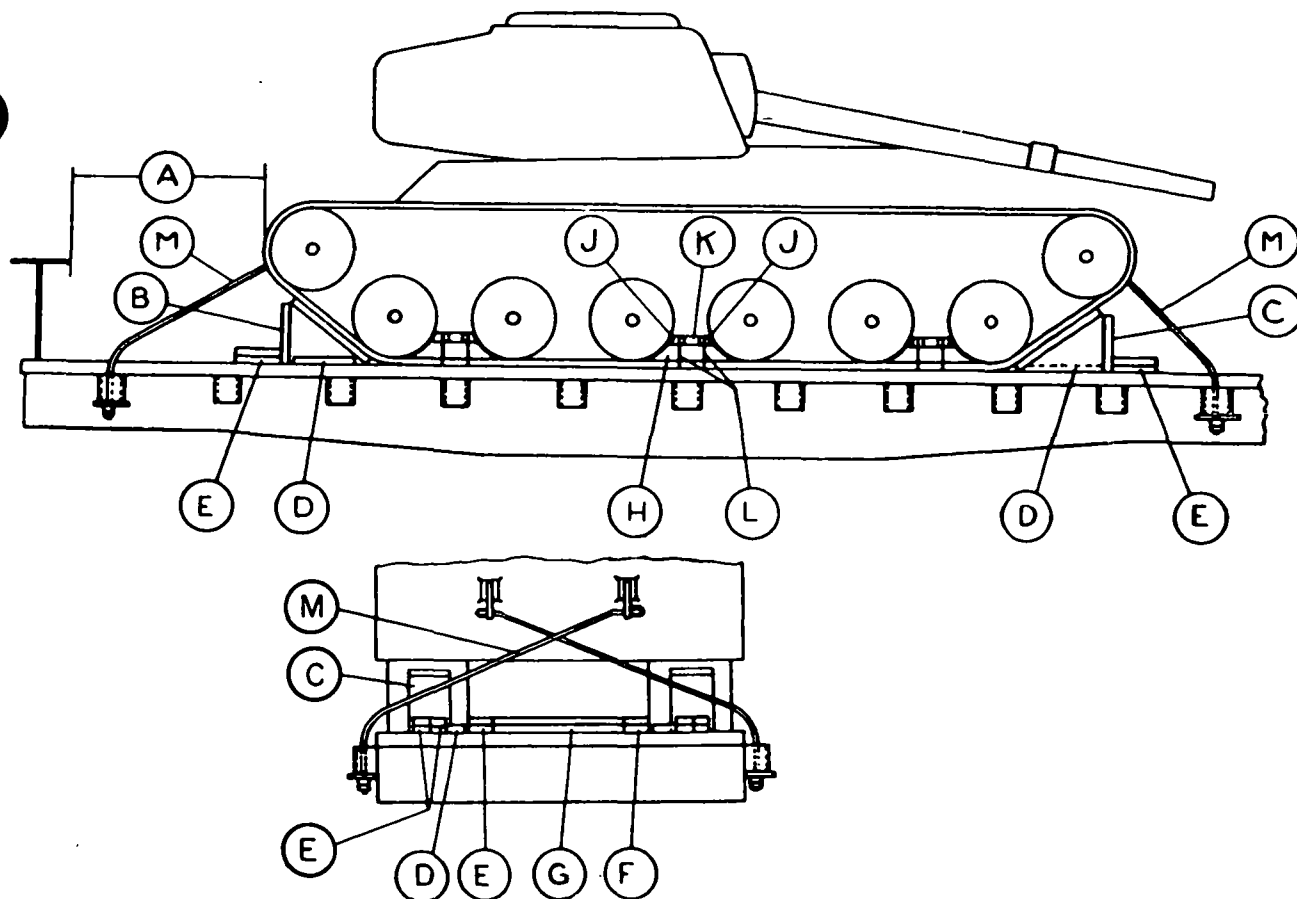


Figure 4-10. Loading a tank or similar unit, 60,000 to 100,000 pounds, on an open-top car.

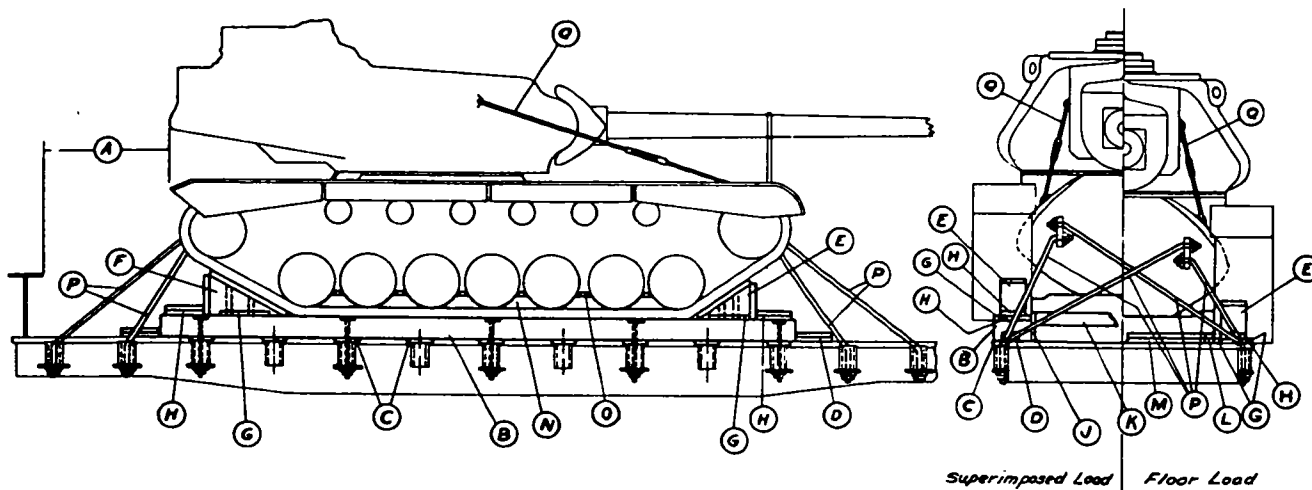


Figure 4-11. Loading tanks and similar units over 100,000 pounds on flatcars.

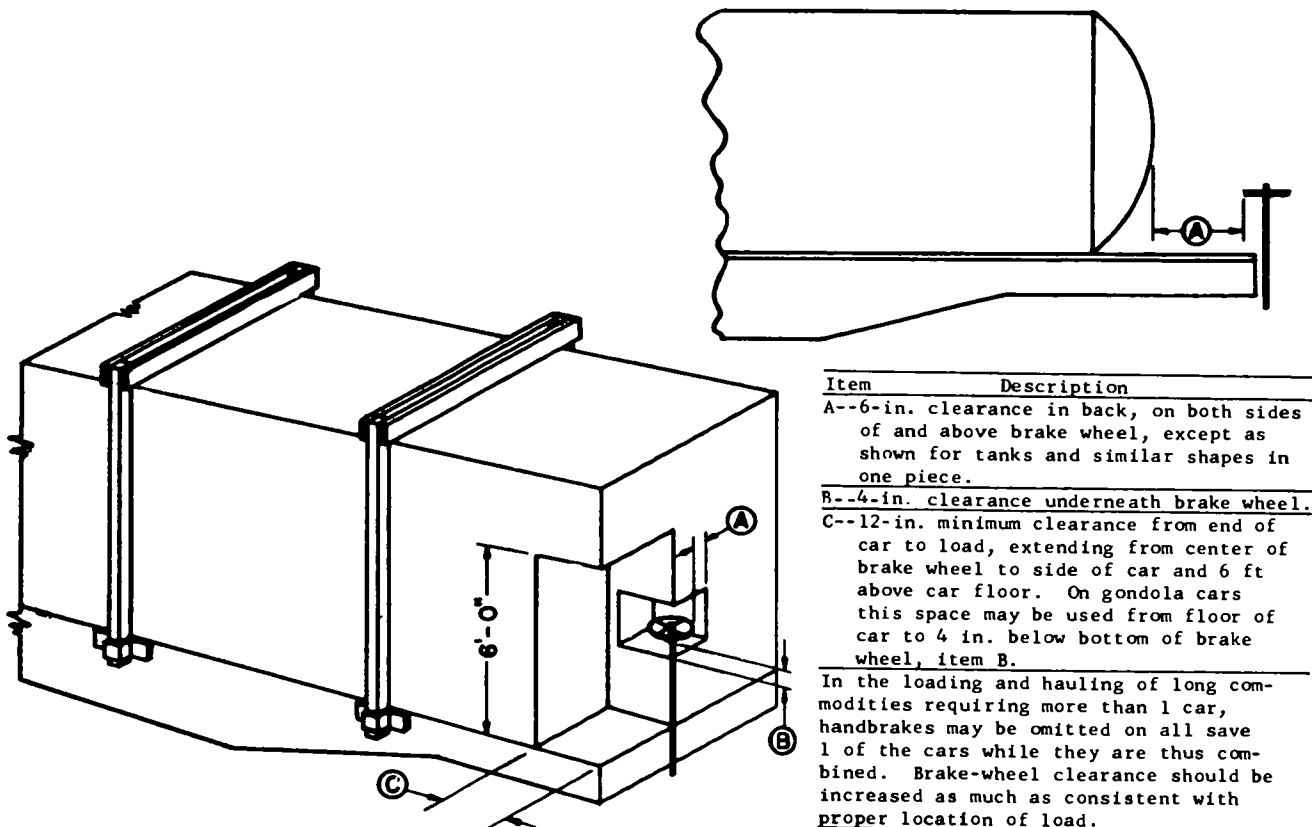


Figure 4-12. Brake-wheel clearance.

4-18. High and/or Wide Loads

a. Cars with high and/or wide loads create an operating hazard: both the cargo and the

personnel working on the line are endangered. Every possible effort must be made to reduce such hazards.

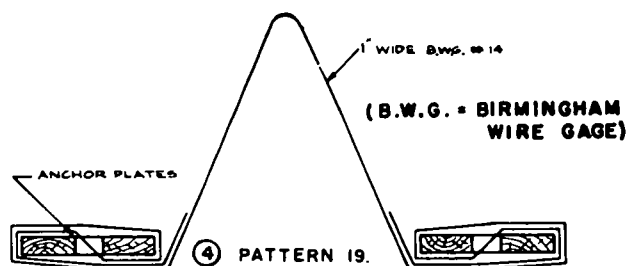
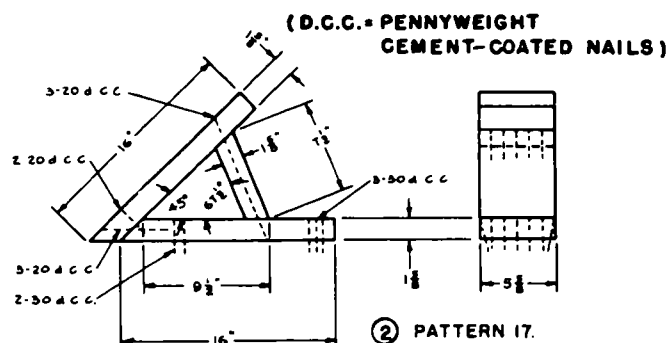
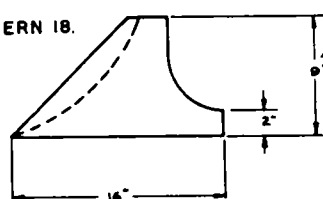
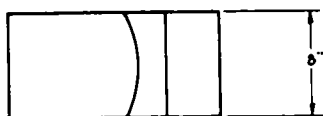
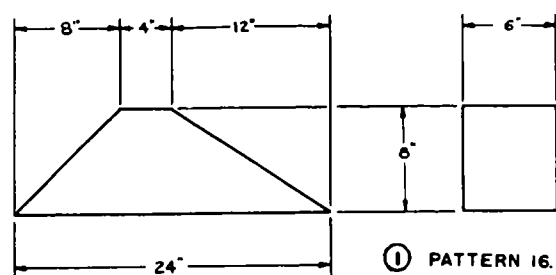


Figure 4-13. Chocks with dimensions and pattern numbers of the Association of American Railroads.

b. The transportation officer initiating a high and/or wide load is responsible for coordinating the shipment with the shipping agency to effect the maximum reductions possible; for example, the removal of spotlights and toolkits, the lowering of booms, and the depressing of gun barrels. Shipping configurations of major items of Army equipment are contained in TB 55-46.

c. When the movement of a high and/or wide load is unavoidable, a scale drawing should be given the serving carrier to determine rail transportability and, if transportable, to make necessary routing instructions.

d. It is essential that the dimensions provided the carrier be accurate and that they reflect the absolute minimum that can be achieved by the shipping agency. (The consignee's ability to reassemble dismantled equipment must be considered.)

e. Whenever possible, an item of equipment should actually be measured to determine its shipping cube. Dimensions from supply manuals, TMs, FMs, etc., should not be used without verification. Incorrect dimensions can be very dangerous and costly.

f. Trains containing high and/or wide loads must be operated at reduced speeds; everyone concerned must be informed of the situation.

4-19. Loading Explosives and Other Hazardous Cargo

For detailed information about handling explosives, see regulations of the Interstate Commerce Commission and pamphlets issued by the Bureau of Explosives, Association of American Railroads and TM 55-602. Basic precautions are—

a. Lost space in loading packages in a car should be avoided by pressing each package firmly toward the end of the car as it is loaded.

b. High pressures on small areas must be avoided. The largest possible area of a package must be used to resist pressures. Bevel-edged boards must be nailed to the car floor to cover defects in the floor or projecting pieces of metal or nails. Cars with corrugated or pressed metal ends, not lined, and cars with bowed ends must be boarded up at the inside of the ends to the height of the load.

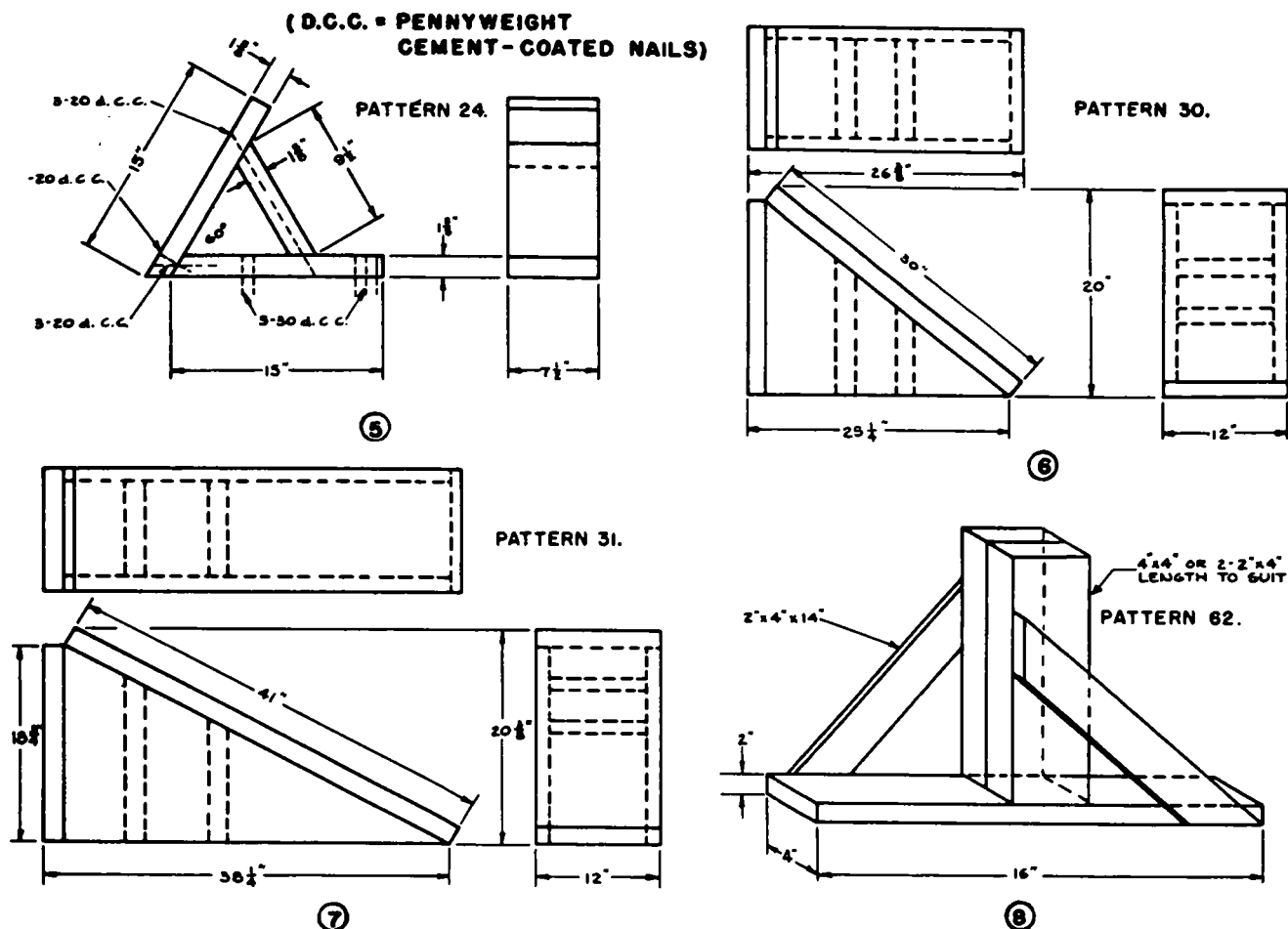


Figure 4-13—Continued.

c. Placing a large shipment in one end of a car must be avoided. A shipment in excess of 12,000 pounds must not be loaded in one end of a car unless other freight is to be loaded in the other end to balance it. Failure to this may cause the car to leave the track.

d. Bracing and blocking must be made with sound lumber, free from cross grain, knots, knotholes, checks, or splits which impair the strength of the material or interfere with proper nailing.

e. Nails should be used plentifully and in the proper places.

(1) Balanced nailing is important. All nails should be of such length as to have the necessary holding power and ample penetration into car walls, floors, or other bracing and

blocking. To obtain the greatest holding power, nails must be long enough to nearly penetrate but not protrude through the timber holding the point of the nail. Nails must not be large enough to cause splitting; they should not be placed along one grain of the wood. Whenever possible, nails should be driven straight—not toenailed. Brass or copper hammers should be used to nail braces around packages of explosives.

(2) The lining of cars is only three-quarters or seven-eighths of an inch thick and has little holding power for large nails. Therefore, nails holding sidewall blocking should be driven into the heavy uprights supporting the lining.

f. The following must not be used:

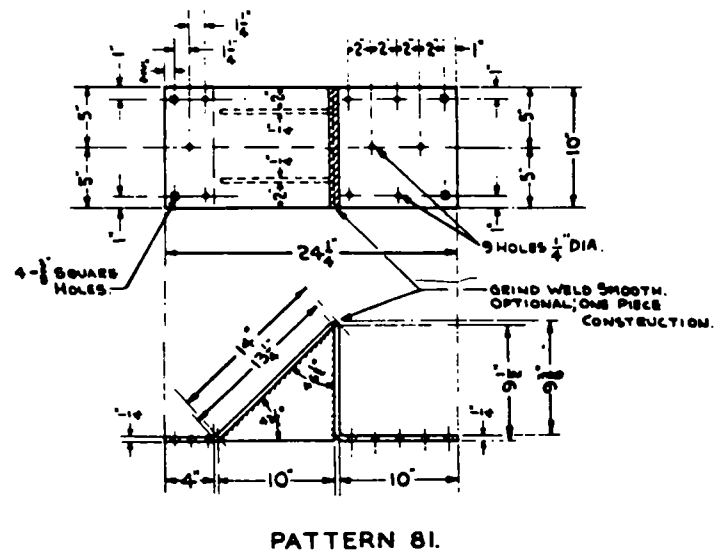
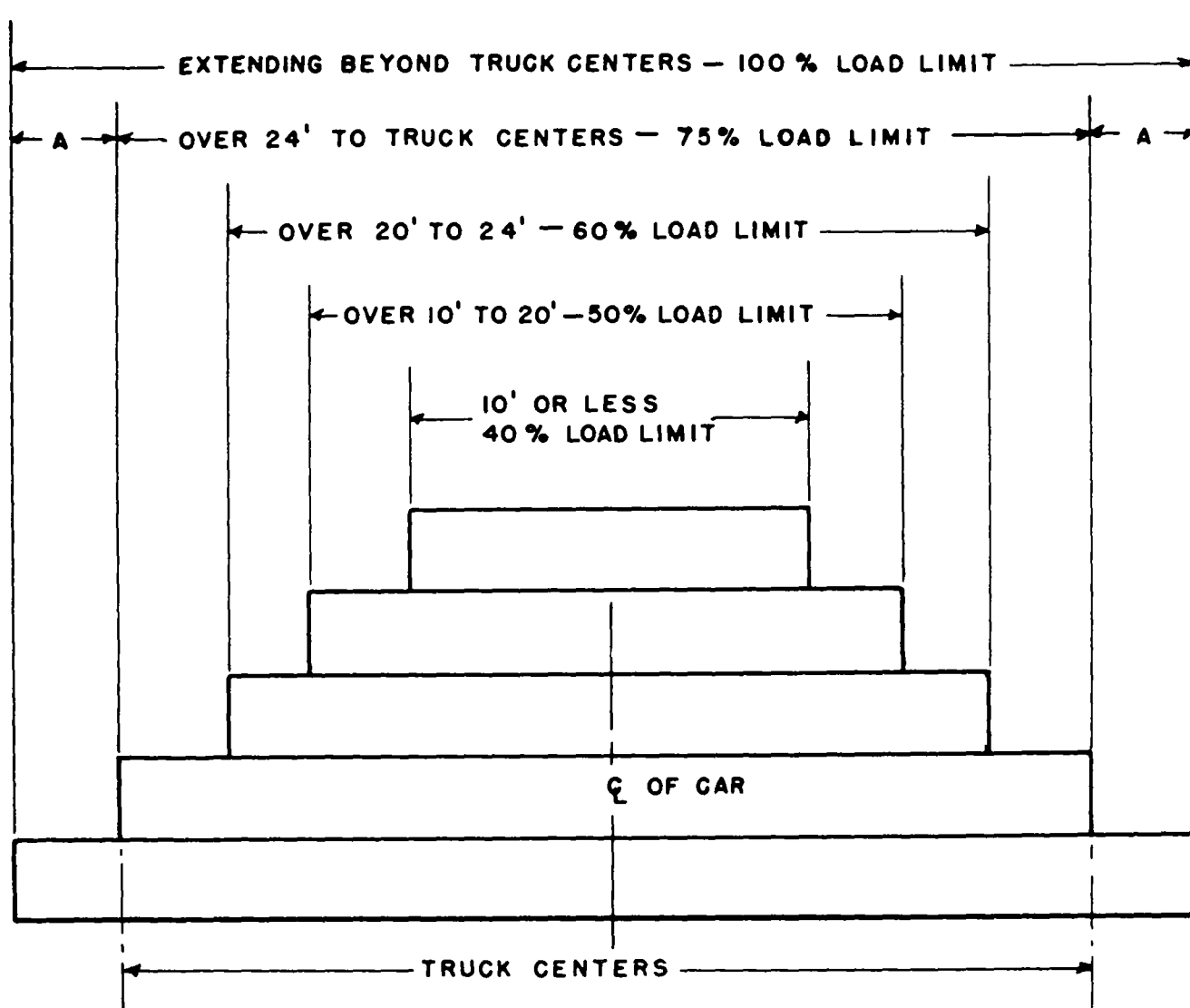


Figure 4-13—Continued.



A=NOT MORE THAN 15% LOAD LIMIT BETWEEN TRUCK CENTERS AND ENDS OF CAR

Figure 4-14. Load limits for explosives.

- (1) Cars with end doors.
- (2) Cars with automobile loading devices unless the loading device is attached to the roof of the car so that it cannot fall.
- (3) Refrigerator cars, except when—
 - (a) Authorized by the carrier or owner,
 - (b) Ice bunkers are protected by solid bracing, and
 - (c) Unfixed floor racks are removed.

g. When heavy loads are handled in and out of cars on lift trucks, a temporary steel plate or other floor protection of suitable size must be used to prevent the truck from breaking through the floor.

h. When loading in closed cars, the following safety rules must be followed:

- (1) Lading must be so secured that it will not come in contact with side doors, or roll or shift in transit.

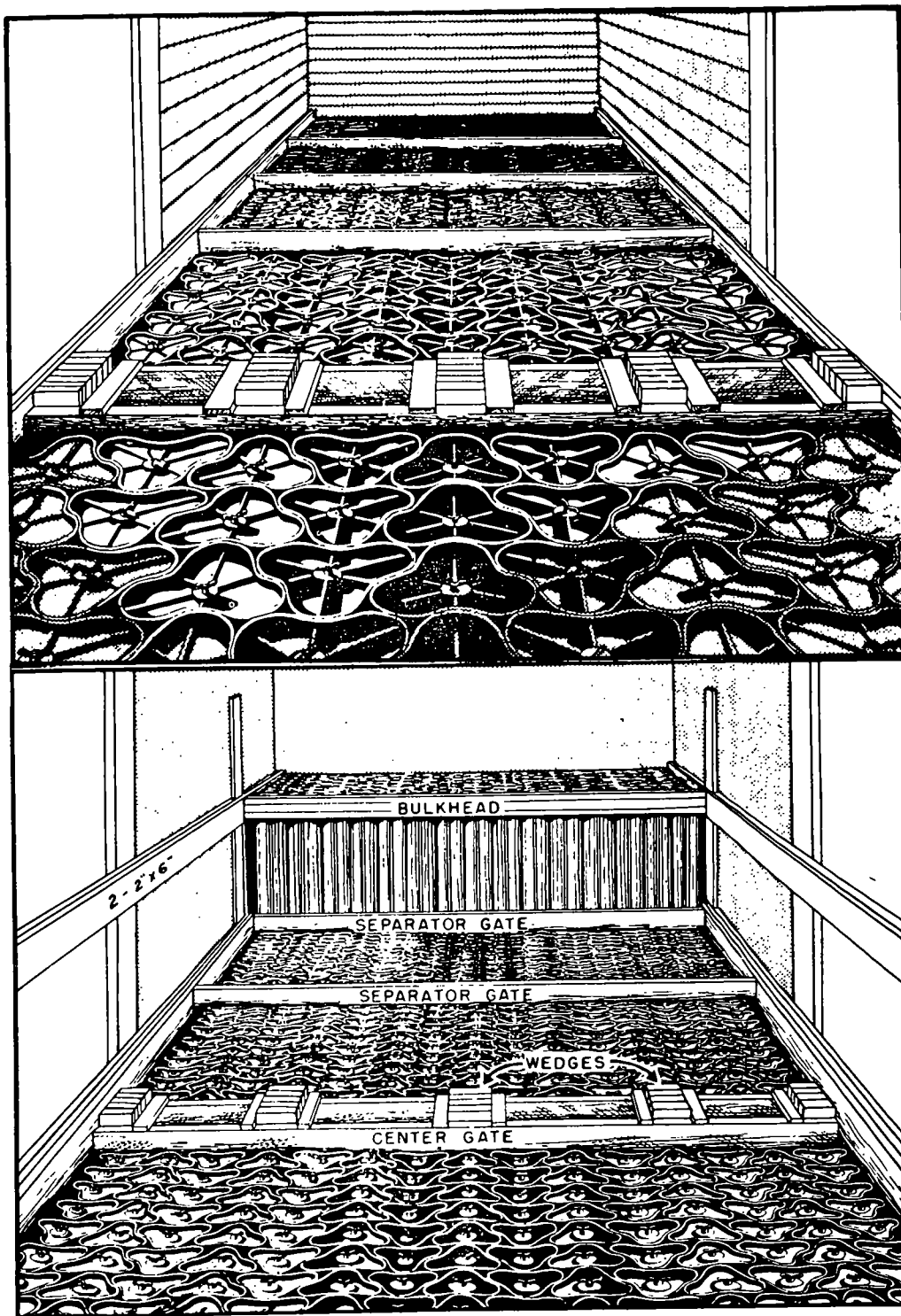


Figure 4-15. Loading and blocking ammunition in cloverleaf packages.

(2) Adequate stripping must be placed across each door opening to prevent lading from falling, rolling out of a doorway, or coming in contact with a door while in transit.

(3) Load must be so placed in the car that there is not more weight on one side than on the other. One truck must not carry more than one-half the load limit stenciled on the car. Cars should be loaded as heavily as possible up to, but not exceeding, the load limit stenciled on the car. Loads should be placed in cars as shown in figure 4-4. The distances shown in the figure represent lengths of different loads. Relative position on the car of each load is also shown.

(4) Material loaded between truck centers and ends of car must not exceed 30 per-

cent of the stenciled load limit (15 percent each end) when both ends are loaded and 10 percent when only one end is loaded. The percentage of stenciled load limits shown in figure 4-14 must not be exceeded for loads located between truck centers, measured lengthwise of car, except when car owner designates otherwise.

i. The following instructions apply in loading and blocking ammunition in cloverleaf packages. Less-than-carload shipments may be loaded and braced in the same manner as the partial shipment shown in figure 4-15. All space between sides of car and rows of bundles must be tightly wedged in place at time of loading. Bulkhead braces for partial layers must be long enough to permit nailing to up-

The Railway Company

EXPLOSIVES

HANDLE CAREFULLY

KEEP FIRE AWAY

STATION _____ 19

CONDENSED RULES FOR HANDLING THIS CAR

1. In switching this car in yards or on sidings have a non-placarded car between this car and engine.
2. This car must not be cut off while in motion.
3. Avoid all shocks to this car. Other cars must not be allowed to strike this car. Couple carefully.
4. When the explosives are unloaded this placard must be removed from car.

Figure 4-16. Explosives placard, rail cars.

Labels must be of diamond shape, white in color, and with each side 4 inches long. Printing must be in red letters inside a red line border measuring $3\frac{1}{2}$ inches on each side.

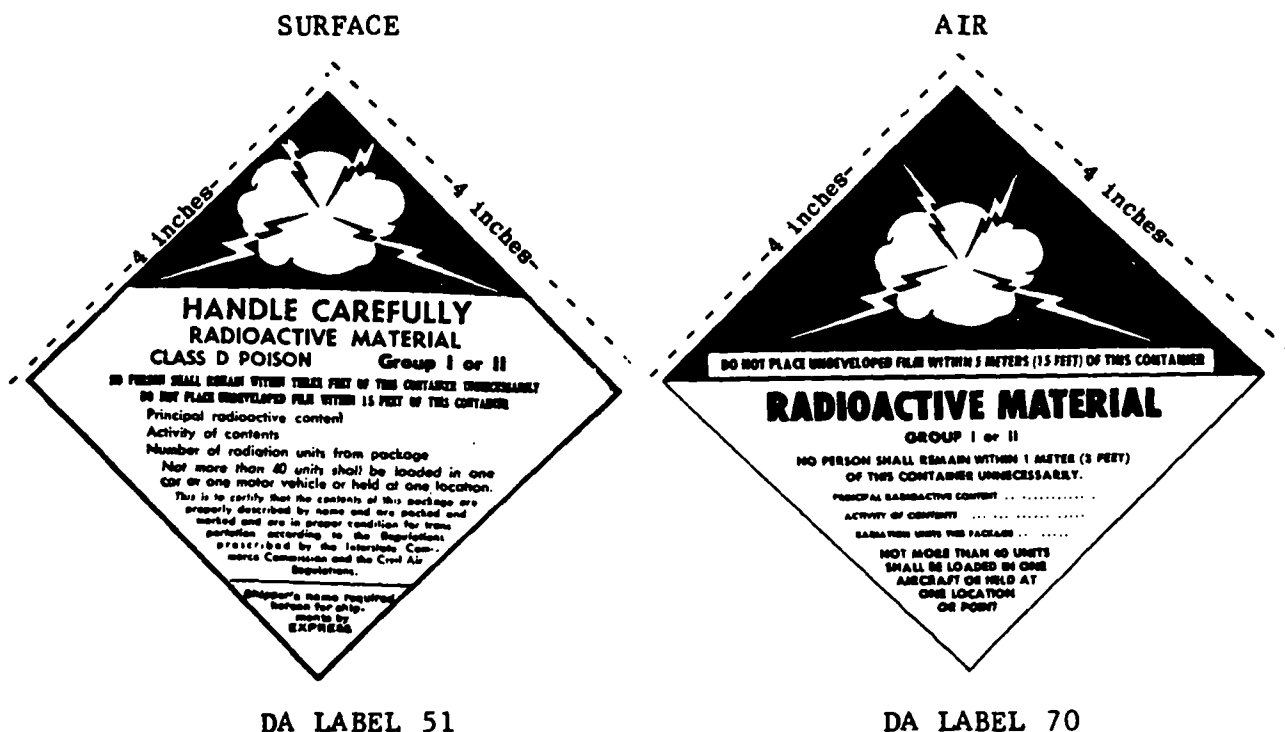


Figure 4-17. Radioactive material labels.

right braces behind car lining. Length will vary, depending on weight of lading supported. The filler strips nailed to the sides of the car must be extended across the doorway. No other doorway protection is required.

4-20. Marking Dangerous-Cargo Cars

a. *Loaded Cars.* Closed cars and tank cars containing dangerous loadings are marked with placards giving the contents. These cards, usually 10 to 14 inches square and printed with large red and black lettering, indicate the contents of the car and give special handling instructions. The placards usually are tacked to placard boards bolted to the outside of the car—one at each end and one on each door on each side of the car. Cars of all-steel construction often have a framed card pocket, one

each in the four locations enumerated, into which the printed placards are slipped.

b. *Empty Cars.* Empty tank cars and box-cars are often placarded with notices that warn of lingering gases and fumes. These warning cards on cars stress that care must be used in switching the cars as well as in unloading their contents.

c. *Examples.* Typical car placards used on commercial and military railroads in the United States are shown in figures 4-16, 4-17, and 4-18, and four-language placards for use by the Army in Europe are shown in figure 4-18.

4-21. Cargo Security

a. *At Origin.*

(1) The shipper is responsible for the

security of carload freight until the car is coupled to a locomotive or train for movement. *The shipper must be fully aware of this responsibility.*

(2) Before loading, the shipper should inspect the car thoroughly to insure that it meets security requirements. Cars with holes or damaged places in floors, roofs, or sides, or insecure doors must be repaired before they are used.

(3) The shipper is responsible for properly loading and bracing the load and for closing and sealing the car. Improperly stowed or braced loads may be damaged in movement and invite pilfering.

(4) Loading should conform to the standards necessary for safe movement under existing operating conditions. In sealing closed cars, the best protection is provided by tightly twisting a 10-inch length of heavy-gage wire

through the locking eyes and snubbing off the wire ends closely. Usually No. 8- or 10-gage wire is used. Zero-gage may be necessary when the pilferage or sabotage threat is acute. The door hasps of closed doors are always sealed with a thin, metallic seal on which a serial number is stamped. This seal is broken easily and provides little protection against pilferage; however, the absence or breakage of a seal indicates tampering. Shipments in open cars should be covered with securely fastened tarpaulins if required by nature of shipment. Small items shipped on flatcars should be fastened securely to the car floor.

(5) The shipper prepares an accurate list of contents, prepares the waybills, and affixes placards to the cars. After a car is loaded, sealed, and documented, it should be moved as quickly as possible.

(6) At military installations the originat-

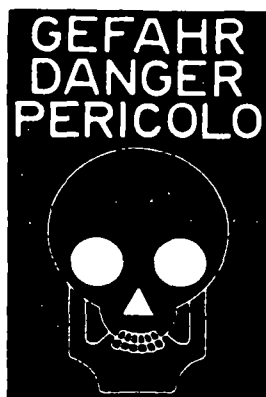


Figure 4-18. Railway car placards, U.S. Army Europe.

ing transportation officer and railway personnel must inspect all open-top cars before movement to insure that they are loaded properly and meet clearance requirements.

b. In Transit.

(1) In CONUS the appropriate commercial railroad and in oversea theaters the transportation railway service is responsible for the security of all carload freight in transit from the time the car is moved from its loading point until it is placed at the designated unloading point. In CONUS the originating railcarrier and in oversea theaters the transportation railway service prepares all car records, train documents, and other records required to insure prompt movement and to prevent loss of cars en route. When operating conditions permit, cars containing freight subject to pilferage are grouped to permit economy in the use of guards. Special handling is given to mail or high-priority traffic of a classified nature.

(2) Train guards are provided by appropriate Army headquarters in CONUS. In oversea theaters, trainguards are provided by military police or other units assigned or attached to the transportation railway service for security duties. These units also guard cars and trains during movement in railroad yards. Sensitive supplies may be guarded by personnel assigned to the car by the loading agency. The yardmaster advises the dispatcher on receipt of cars with special guards. He also notes the receipt on the train consist that is transmitted to yards and terminals. This insures that all railway personnel avoid delays in transit and expedites placement at the destination.

(3) Guard crews check car seals and inspect trains for cars that are not secure. They prepare a record, by car number, of all guarded cars in trains, noting any deficiencies or incidents en route. When relief guard takes over, the crews make a joint inspection and sign this record.

(4) When a bad-order car containing supplies subject to pilferage is set out, a member of the guard crew should remain with the car until he is properly relieved. Guard crews must be alert at all times, particularly when

the train has stopped, and when it is passing through tunnels, cuts, and villages at slow speed.

c. At Destination.

(1) The consignee becomes responsible for carload freight when it is placed at the depot, siding, or track he designates. Cars should be unloaded as quickly as possible to lessen chances for pilferage.

(2) In removing wire seals from closed cars, care must be taken to avoid breaking latches on the car door. Wire cutters are recommended for this purpose.

4-22. Troop Movements

a. Space Requirements. For planning purposes, the following capacity data may be used when loading troops on U.S. equipment (other details contained in TM 55-601).

(1) *Sleeping cars (average).* Thirty-two troops with individual equipment.

(a) Officers and warrant officers are moved in standard pullmans, 2 per section, and are listed by number of sections; for example, 14 officers are shown as 7 sections. Officers and warrant officers of all units in one train will be grouped in one or more pullman cars as required.

(b) Enlisted men move in tourist pullmans, usually two per section. NCOs of the first five grades are entitled to separate berths. Space must be provided for personnel attached from medical units and men detached as guards on freight cars.

(2) *Coaches (average).* Fifty-five troops with individual equipment.

(3) *Passenger trains (long-distance moves, average).* Eleven sleeping cars, 2 kitchen cars, 1 or 2 baggage cars; 350 troops per train is typical.

(4) *Freight trains.* For troop-unit moves, including such heavy equipment as tanks, artillery, and engineer equipment, trains seldom exceed 65 cars (650 short tons) for infantry divisions; 55 cars (1,200 short tons) for armored divisions.

(5) *Mixed trains.* Desirable from a tacti-

cal and organizational standpoint, since they carry all personnel with their vehicles, artillery, and equipment. Not economical when passenger equipment is in short supply because they move at freight train speed. In mixed trains, boxcars should be substituted for baggage cars.

(6) *Kitchen-baggage cars.* Furnished on the basis of 1 per 250 men or fraction thereof. Requirements per train depend upon how transportation is grouped. For tentative estimates, allow one per unit.

(7) *Flatcars.* Number required is computed on the basis of maximum utilization of each car, regardless of length. Computation is not restricted to cars of one length. Twelve inches is left clear at one end of each car for brake-wheel clearance.

b. Organizational Equipment.

(1) Amount of headquarters, kitchen, and maintenance equipment varies somewhat in all units. For planning, allow 20 short tons per company or equivalent unit.

(2) Organizational equipment is usually loaded in unit transportation; loading it separately requires more boxcars. Checkable baggage up to 150 pounds is carried free; generally, this is loaded in a baggage car or boxcar. When transportation groupings permit, checkable baggage for two companies or similar units may be loaded in one boxcar.

c. Foreign Railways.

(1) Few foreign railways are capable of moving complete troop units by rail at the same time the rail net is supplying a major force. Accordingly, tracked vehicles and foot troops may move by rail while wheeled vehicles with their normal towed loads move on highways.

(2) For planning, the following capacities may be assumed:

(a) Freight cars.

Well flatcars	50 short tons
Medium flatcars	25 short tons
Small flatcars	12 short tons
Boxcars	10 short tons or 25 troops

(b) Passenger cars.

Coaches	40 troops
Sleeping cars	32 troops

4-23. Troop-Train Commanders

a. Assignment.

(1) An officer in charge of troops (train) is appointed or detailed for all troop trains. He is usually senior officer commanding troops.

(a) If only one unit is involved, he may be detailed by headquarters of unit ordered to move.

(b) If more than one unit is moving, he may be appointed by transportation movements officer at entrainment station unless an officer has been appointed by higher headquarters.

(2) If the troops are of mixed nationalities, the senior officer commanding troops, regardless of nationality, is troop-train commander; in cases of equal senior rank, the commander of largest number of troops served will be the troop-train commander.

(3) He serves until journey is completed, regardless of officers boarding train en route.

b. Duties.

(1) *Administration.* the troop train commander—

(a) May appoint one or more officers as assistants. When troops of other nationalities are traveling on same train, officers of the nationalities concerned are appointed as assistants.

(b) Complies with instructions received en route from the responsible transportation movements officer.

(c) Ascertains details of loading baggage, vehicles (if any), and personnel from transportation movements officer, station-master, or port commander if moving from a port.

(d) Submits troop-movement order to transportation movements officer.

(e) Makes location of troop-train commander's headquarters on train known to all troops.

(f) Gives order of entrainment; directs entrainment, noting location of various units and their baggage.

(2) *Discipline.* The troop-train commander—

(a) Is responsible for the protection, discipline, and conduct of all troops aboard the train.

(b) Directs that separate accommodations be provided for all females traveling; details an officer to any car in which separate compartments are occupied by male and female personnel to insure observance of proprieties.

(c) Issues orders that prohibit—

1. Discussing the move with unauthorized persons.
2. Detraining without orders.
3. Throwing rubbish out of windows.
4. Leaning out of windows.
5. Damaging railway property.
6. Marking or writing on side of cars.
7. Violating blackout.
8. Wasting water in lavatories.
9. Riding on trains except where authorized.
10. Using intoxicants.
11. Using train latrines while in stations.

(3) *Sanitation.* The troop-train commander is advised by train crew of—

(a) Approximate time and duration of rest stops to be made during a long journey.

(b) Whistle signal to be used for notification of such stops.

(4) *Air defense.* The troop-train commander will—

(a) Interrupt movement program only if assault is specifically directed against the destination station.

(b) Be prepared to assist local anti-aircraft after consultation with transportation movements officer.

(c) Enforce blackout.

(5) *Defense against ground attack.* This will depend upon the area involved, type and degree of attack, and the forces available to the troop-train commander. He should follow instructions and/or SOP provided by the local commander.

4-24. Estimating Railway Capacity

Since the direction of military supply move-

ments is primarily forward, military rail line capacity estimates generally are based on net tonnage moved in one direction. However, total capacity is based on train density and must take into consideration movements of trains in both directions. When the railway net under consideration is composed of several divisions and branch lines, separate estimates should be made for each division and branch line. In estimating railway line capacity in terms of payload hauled, the limiting factors are the power of the locomotive and resistance offered by the grade, the curve, the locomotive, the cars, the lading, and the weather. The formulas and factors presented in the following paragraphs are listed in the order in which they must be considered.

4-25. Weight on Drivers

a. *General.* The weight on drivers of a locomotive is expressed in short tons. It is that weight which is supported by the coupled driving wheels when they rest on a straight and level track. It does not include any of the remaining portion of the locomotive's weight. Different types and classes of locomotives have different weight. All locomotives are constructed to specifications issued by the purchaser, the using railroad, or the manufacturer.

b. *Army Locomotives.* The weights on drivers of some common types of locomotives used by the Department of the Army are included herein for ready reference. A complete table of Army locomotive characteristics is contained in table I, FM 55-21.

(1) Diesel-electric locomotive.

Type	Weight on drivers (STON)	Horsepower
0-6-6-0, standard-gage	131	1600
0-6-6-0, multi-gage	127	1600
0-4-4-0, standard-gage	120	1200
0-4-4-0, standard-gage	120	1500
0-4-4-0, standard-gage	80	1000

(2) Steam locomotives.

0-6-0, standard-gage	80	----
2-8-0, standard-gage	82	----

4-26. Tractive Effort (TE)

a. *General.* Tractive effort is a measure of

the potential power of a locomotive expressed in pounds; it is the horizontal force which a locomotive can exert, providing that the wheels do not slip. A locomotive's tractive effort is included in the data supplied by the manufacturer. The tractive effort of some locomotives used by the Department of the Army will be found in table I, FM 55-21. When such data are not available, tractive effort can be computed using the formulas. Due consideration must be given to the locomotive's age and condition.

b. Starting and Continuous Tractive Effort. Starting tractive effort is the power that a locomotive has available to move itself and the load it is hauling from a stopped position. Continuous tractive effort is the effort required to keep a train rolling after it has been started. As the train increases in momentum, the tractive effort necessary diminishes rapidly. In steam locomotives no differentiation is made between starting and continuous tractive effort. A steam locomotive can generally continue to pull what it can start. However, a diesel-electric locomotive cannot continue to exert the same force achieved in starting without damaging its power unit. The continuous tractive effort of a diesel-electric locomotive is approximately fifty percent of its starting tractive effort.

c. Rule-of-Thumb Method of Determining Tractive Effort.

(1) Starting tractive effort is closely correlated to the adhesion which the driving wheels maintain at the rails. If the tractive effort expended exceeds this adhesion element, the drivers will slip. Normally, the adhesion element when the rails are dry is 30 percent of the weight on drivers; when the rails are wet, 20 percent. Therefore, 25 percent is taken as the average.

(2) Thus, for a locomotive weighing 80 tons or 160,000 pounds on drivers, the approximate starting tractive effort would be $\frac{160000}{4}$ or 40,000 pounds.

(3) If it were a steam locomotive, the con-

tinuous tractive effort of the above locomotive would also be 40,000 pounds. If it were a diesel-electric locomotive the continuous tractive effort would be approximately $\frac{40000}{2}$ or 20,000 pounds.

4-27. Drawbar Pull

a. General. Drawbar pull is the actual pulling ability of a locomotive, less the effort necessary to move the locomotive. Actual tests have indicated that 16 to 20 pounds of pull per ton are required to start the average locomotive or freight car on straight, level track under favorable weather and temperature conditions. A locomotive or car equipped with roller bearings will start with somewhat less effort. For railway planning, 20 pounds per ton will be used. This resistance drops after equipment starts rolling; but to establish pulling ability (drawbar pull) available for starting and pulling a train, 20 pounds per ton of locomotive weight will be subtracted from the continuous tractive effort of the locomotive. Thus, a diesel-electric locomotive weighing 80 tons on drivers and having a continuous tractive effort of 20,000 pounds has a drawbar pull of 18,400 pounds (20,000 pounds minus 1,600 pounds).

b. Speed Factors. Maximum drawbar pull can be exerted only at lowest speeds—up to approximately 10 miles per hour—after which it drops off sharply. Drawbar pull at given speeds can be obtained by applying a speed factor to the maximum drawbar pull. However, speeds are different for different types of locomotives. In one type of steam locomotive, drawbar pull was found to diminish in inverse ratio to speed. For example, drawbar pull is 80 percent at 20 miles per hour, 50 percent at 50 miles per hour, and 20 percent at 80 miles per hour. This may be used as a rule-of-thumb for estimating drawbar pull of steam locomotives at various speeds. The drawbar pull of diesel-electric locomotives diminishes more rapidly at the higher speeds.

4-28. Rolling Resistance

The force components acting upon a train in a direction parallel with the track which tend to hold or retard the train's movement constitute rolling resistance. The components of rolling resistance are friction between the railheads and the treads and flanges of the wheels, resistance due to undulation of track under a moving train, internal friction of rolling stock, and resistance in still air. An absolute figure to be used as rolling resistance is unknown. Experience indicates that a safe average value to use in the theater of operations for rolling resistance is as shown below:

Pounds per ton of train	Track condition
5 -----	Excellent
6 -----	Good to fair
7 -----	Fair to poor
8 -----	Poor
9-10 -----	Very poor

4-29. Grade Resistance

As determined by the following formula, grade resistance is equal to 20 pounds per ton of train times the rate percent of grade.

$$R_g = \frac{WR}{B}$$

Where R_g = grade resistance
 W = 1 ton (2000 pounds)
 R = rate percent of grade
 B = one station (100 feet)

Thus, R_g in pounds per ton may be expressed

$$R_g = \frac{2000 \times \text{percent of grade}}{100}$$

4-30. Curve Resistance

No entirely satisfactory theoretical discussion of curve resistance has been published; however, engineers in the United States usually allow from 0.8 to 1 pound per degree of curve. In military railway planning, the factor 0.8 pound per ton of train per degree of curve is used. The continual passing of trains around a curve eventually moves the track, which disturbs alinement and distorts the curve. The track should be restored to its correct curvature after determining whether any distortion

exists. This should be done by TRS maintenance-of-way personnel. A field expedient for determining the curvature of a track is the string method (para 4-44).

4-31. Weather Factor

a. General. The weather factor is another expression of train resistance. It reflects, by percentage, the effects of adverse cold and wet weather upon actual hauling power of a locomotive. Experience and tests have proved that whenever the temperature drops below 32° F, the hauling power of the locomotive is decreased. Table III, FM 55-21, shows the weather factor (percent) for different degrees of temperature.

b. Ordinarily, wet weather is regarded as local and temporary and is disregarded in normal planning. However, in countries of extended wet seasons the loss of tractive effort due to slippery rail may prove serious if sanding facilities are inadequate. The applicable reduction is a matter of judgment but, in general, tractive effort will not be less than 20 percent of weight on drivers.

4-32. Gross Trailing Load (GTL)

Gross trailing load is the maximum weight or load in short tons that a locomotive may safely pull under given conditions of curvature, grade, or on level track. It is determined by combining all of the factors discussed in the preceding paragraphs. When double-heading with steam locomotives or using pushers, the GTL is equal to the sum or the GTL of the two locomotives (or 100 percent of the total GTL for diesel-electric locomotives). The formula for gross trailing load is as follows:

$$GTL = \frac{DBP \times W}{RR + GR + CR}$$

Where GTL = gross trailing load
 DBP = drawbar pull
 W = weather resistance
 RR = rolling resistance
 GR = grade resistance
 CR = curve resistance

4-33. Net Trainload (NTL)

Net trainload is the payload carried by the train. The total weight of cars under load is gross weight. The light weight, or weight of cars empty, is tare. The difference between these two is the net load or payload of the train. In military railway planning, the net trainload is taken as 50 percent of the gross trailing load.

4-34. Train Density (TD)

a. General.

(1) The term train density is used to denote the number of trains that may be operated safely over a division in each direction during a 24-hour period. Work trains are not included in computing train density. However, their presence on divisions, and the amount of time they block the main track, can reduce the density of a rail division. Train density may vary greatly over various divisions due to the condition and length of the main line, number and location of passing tracks, yard and terminal facilities, train movement control facilities and procedures, availability of train crews, motive power, and rolling stock.

(2) On a single-track line, passing tracks are normally 6 to 8 miles apart. When multiple tracks (three or more) are encountered, they generally will be considered as double track since it is frequently necessary to remove a portion of the third and fourth tracks in order to maintain the double track line.

(3) The capacity or operating turnover of cars and trains in and out of terminal yards must be considered, either from definite experience and intelligence factors or by inference from other related information.

(4) The following rule-of-thumb and formula are primarily designed to determine freight train density; however, they will be reasonable accurate on lines having 20 percent passenger trains included.

b. Rule-of-Thumb for Determining Train Density. In the absence of sufficient intelligence upon which to evaluate the potential train density of a rail line, a train density of

10 for single track and 30 for double track will be used as planning factors.

c. Formula for Determining Single-Track Train Density. When sufficient operational intelligence is available, the following formula and factors may be used in determining train density for a specified railway division. In determining the number of passing tracks, those less than 5 miles apart should not be included. Passing tracks selected should be uniformly spaced throughout the division.

$$TD = \frac{NT + 1}{2} \times \frac{24 \times S}{LD}$$

Where *TD* = train density

NT = number of passing tracks

1 = constant (number of trains that could be run if there were no passing tracks)

2 = constant to convert to one direction

24 = constant (number of hours per day)

S = average speed (table IV, FM 55-21)

LD = length of division

d. Formula for Determining Double-Track Train Density. In determining the train density for double-track operations, fluidity and flexibility must be maintained. Thus, the number of trains operated should not exceed that number which can be cleared off either main track in case of emergency at any given time. Using the factors in *c*, above, train density for double track may be computed as follows:

$$TD_2 = (NT + 1) \times \frac{24 \times S}{LD}$$

4-35. Net Division Tonnage (NDT)

a. Net division tonnage is the tonnage in short tons, or payload which can be moved over a railway division (90-150 miles) each day. It includes railway operating supplies which must be programed for movement the same as the supplies of any other service.

b. Net division tonnage is determined by multiplying the net trainload (NTL) by the train density (TD) of the particular division.

Net division tonnage is computed separately for each division.

c. When calculating net division tonnage, certain other factors must be taken into consideration. For example, troop, passenger, or hospital trains will replace an equal number of tonnage freight trains. When the operation of such trains is anticipated, allowance in net division tonnage estimates is made by adjusting the train densities of the divisions concerned.

4-36. End Delivery Tonnage

In military operations, the end delivery tonnage measured in short tons which is delivered at the end of the railway line (railhead) each day. In all all-rail movement, the end delivery tonnage is the same as the net division tonnage of the more restrictive division.

4-37. Miscellaneous Operational Values

a. Effect of Temperature on Hauling Power of Locomotives.

Temperature (°F)	Loss in hauling power (percent)
Above + 32	0
+31 to +16	5
+15 to 0	10
-1 to -10	15
-11 to -20	20
-21 to -25	25
-26 to -30	30
-31 to -35	35
-36 to -40	40
-41 to -45	45
-46 to -50	50

b. Average Rolling Resistance Values.

Condition of truck	Pound per ton of train
Exceptionally good	5
Good to fair	6
Fair to poor	7
Poor	8
Very poor	9 to 10

c. Terminal Times.

Type of locomotive	Hours
Steam	8
Diesel-electric	3

d. Rolling Stock.

(1) Freight.

(a) Requirements are computed separately for operations between major supply installations or areas on each line of communication as follows:

$$\frac{\text{Daily tonnage}}{\text{Average tons per car}} \times \text{turnaround time} = \text{number of cars}$$

Turnaround time is the total estimated number of days required for a car from the time it is placed for loading at its point of origin, moved to its destination, unloaded, and returned to its point of origin. Such time may be computed as follows: Allow 2 days at origin, 1 day at destination, and 2 days' transit time for each division, or major portion thereof, which the cars must traverse. This method, rather than an actual hour basis, is used to incorporate delays due to terminal and way-station switching as well as intransit rehandling of trains.

Rolling stock	
Location or type of operation	Days' dispatch required
At base of operation	2
Forward traffic	1 per division
Return traffic	1 per division
At railhead	1

(b) Computations should be increased by 10 percent to meet operational peaks, commitments for certain classes of cars, and bad order cars.

(c) An average planning factor for net load per car may be assumed as follows:

Standard gage to broad gage	
U.S. equipment	20 tons
Foreign equipment	10 tons

Narrow gage	
U.S. equipment	15 tons
Foreign equipment	7½ tons

(d) Tank car requirements are computed separately based on the bulk POL requirement and the computed turn-around time.

(2) Passenger.

(a) Passenger car requirements will vary, depending on troop movement policies, evacuation policies, and rest and recuperation policies.

(b) Theater passenger car requirements are fulfilled by acquisition of local equip-

ment with the exception of hospital cars and trains.

e. Road Locomotives. The number of road locomotives required for operation over a given railway division may be determined by the following formula:

$$\text{Road locomotives required: } \frac{TD \times (RT \times TT) \times 2 \times 1.20}{24}$$

where TD = train density

RT = running time (length of division divided by average speed)

TT = terminal time (time for servicing and turning locomotive)

24 = number of hours per day

2 = constant for two-way traffic

1.20 = constant allowing 20 percent reserve

Note. The expression $RT \times TT$ is the percent of time during a 24-hour period in which a road locomotive is in use and is called the locomotive factor. The expression provides for the pooled use of motive

power which may make one or more trips per day over a short division.

f. Switch Engines.

(1) The number of switch engines required at a terminal is based on the number of cars dispatched and received, or passing through the terminal per day. When the number of cars has been computed, that figure is applied to the table in (2) below to determine the number of switch engines required at each terminal.

(2) When the total number of switch engines required for the railway line has been computed, add 20 percent as a reserve to allow for maintenance, operational peaks, etc.

Switch engines	
Type of terminal	Number of engines
Port, railhead, loading, unloading.	1 per 67 cars dispatched and received per day.
Division	1 per 100 cars passing per day.

g. Fuel Requirements.

Type of locomotive	Type of operation	Estimated average rate of fuel consumption					
		Coal (lb)	Per train mile		Per hour		
			Oil (lb)	Oil (gal.)	Coal (lb)	Oil (lb)	Oil (gal.)
Steam (coal-burning) :							
2-8-0, 82-ton, standard gage.	Road	90	---	---	700	---	---
2-8-0, 90-ton, standard gage.	-----	115	---	---	950	---	---
2-8-2, 60-ton, narrow gage.	Road	100	---	---	750	---	---
Steam (oil-burning) :							
2-8-0, 82-ton, standard gage.	Road	---	55	---	---	450	---
2-8-2, 60-ton, narrow gage.	Road	---	60	---	---	500	---
Diesel-electric :							
0-6-6-0, 120-ton, standard gage.	Road switcher	---	---	2.5	---	---	11.5
0-4-4-0, 60-ton, standard gage.	Road switcher	---	---	0.9	---	---	8.0
0-6-6-0, 80-ton narrow gage.	Road switcher	---	---	1.5	---	---	10.0
0-4-4-0, 48-ton, narrow gage.	Road switcher	---	---	0.9	---	---	8.0

h. Determining Average Speed Values. For planning purposes, average speed values can be estimated by using the table below. To determine speed, select the most restrictive factor of the eight factors shown. If the restrictive factor(s) is not known, use an average speed value of 8 mph (13 kmph) for a single track and 10 mph (16 kmph) for double track. If the most restrictive factor affects only a

comparatively short distance (10 percent or less) of the division, use the next higher average speed. If the average speed falls below 6 mph (10 kmph) because of the gradient, reduce tonnage to increase speed. (A 2-percent reduction in gross tonnage increases speed 1 mile per hour.) If the ruling grade materially affects the tonnage, consider using helper service.

Restrictive factors Condition of track	Percent of grade	Average speed		Double track	
		Single track	Double track		
		mph	kmph	mph	kmph
Exceptionally good -----	1 or less	12	19.3	14	22.5
Good to fair -----	1 to 1.5	10	16.1	12	19.3
Fair to poor -----	1.5 to 2.5	8	12.9	10	16.1
Poor -----	2.5 to 3	6	9.6	8	12.9

Section IV. CONSTRUCTION, MAINTENANCE, AND SUPPLY

4-38. Construction Requirements

a. New Construction.

(1) For planning purposes, a railroad division includes 100 principal-route miles of main line, single- or double-track, with its terminal operating and maintenance facilities, fueling and watering facilities, and the signaling equipment or interlocking facilities necessary for safe operation. Passing sidings on single-track lines, crossovers on double-track lines, and stations are located at intervals as

required by traffic. Normally, at least one spur or siding is provided at each station. The engineer service in the theater of operations is responsible for new rail construction and large-scale rehabilitation. Transportation railway service maintenance-of-way personnel, however, may be required to assist engineer personnel in the latter work.

(2) The following table shows the materials and net effective man-hours required for new construction of 1 mile of standard-gage (56½-inch), single-track railroad.

Item	Short tons	Measure- ment tons	Man- hours
Grading -----	-----	-----	^a 4,000
Ballast delivered -----	-----	-----	^b 2,500
Track laying and surfacing -----	-----	-----	2,570
Bridging—70 linear feet per mile -----	101	111	2,200
Culverts—7 per mile average 40' length -----	8	7	1,400
Ties—2,900 -----	218	300	-----
Rail—90 pounds -----	160	45	-----
Fastening (based on 39-foot rail) -----	33	10	-----
Total -----	520	473	12,670

^a Includes clearing based on average wooded terrain.

^b Bank run material, average haul—5 miles.

b. *Rehabilitation.* The following table reflects the rehabilitation requirements that can be anticipated for a 100-mile (161-km) standard-gage, single-track division extending inland

from a port, using average percentage of demolition over the entire division. For further information, see FM 55-21.

Item	Quantity per 100 miles	Percent of demolition	Rehabili- tation (quantity)	Material ¹	Measure- ment tons	Man- hours ¹ (thou- sands)
Main line -----	100 mi	13	13 mi	3,820	2,514	68
Port trackage ² -----	3 mi	100	3 mi	1,440	1,098	22
Passing sidings ² -----	4.5 mi	80	3.6 mi	1,730	1,320	17
Station sidings ² -----	3 mi	80	2.4 mi	1,150	880	12
Railway terminal ^{2,3} -----	1 ea	75	0.75 ea	7,100	5,800	160
Water stations -----	3 ea	100	3 ea	135	210	9
Fuel stations -----	1 ea	100	1 ea	21	18	1
Bridging -----	7,000 linear ft	70	4,900 linear ft	8,950	7,770	154
Culverts -----	28,000 linear ft	15	4,200 linear ft	120	105	21
Grading -----	-----	-----	-----	-----	-----	35
Ballast -----	-----	-----	-----	-----	-----	44
Totals -----	-----	-----	-----	20,715	24,466	543

¹ Tunnels require special consideration. To repair (by timbering) a 50-foot demolition at each end of a single-track tunnel (100 ft total per tunnel), allow 70 tons, 87 measurement tons, and 3,000 man-hours.

² Estimate includes ties, rails, fastenings, turnouts, tracklaying and surfacing. It assumes ballast is available at worksites.

³ Includes replacement of buildings 100 percent, ties 30 percent, rail and turnouts 85 percent.

4-39. Maintenance Responsibilities

a. After railways are constructed and turned over to the transportation railway service for operation, minor railway maintenance in the communications zone and in the combat zone to the forward limit of traffic is the responsibility of the transportation railway service.

b. The transportation railway service is responsible for the maintenance of the railway communications circuits that are used exclusively for the operation and administration of the railways. This responsibility becomes effective when all the circuits on the line have been turned over to the transportation railway service for administration and operation. The transportation railway service is responsible for the operation and for the organizational and direct support of railway block signals, of interlocking plants, and of centralized traffic control devices. It is also responsible for the installation, maintenance, and operation of internal communications.

c. The transportation railway system is normally divided into a number of divisions for maintenance and operation. Each division is assigned a railway battalion; each battalion includes personnel from the railway engineering company to perform necessary maintenance of tracks and structures.

d. The battalion commander has overall responsibility for railway maintenance, including maintenance work, instructions, and procedures. The company commander of the railway engineering company is maintenance-of-way superintendent and is directly responsible for the maintenance of tracks and structures, for the proper supervision of all maintenance work and procedures, and for the necessary inspection of track and structures on the division. Platoon and section leaders are charged with the proper supervision of assigned maintenance operations.

4-40. Maintenance Categories

a. *General.* Army maintenance is divided into four categories: organizational, direct support, general support, and depot.

b. *Locomotives.*

(1) Organizational maintenance consists of during-operation maintenance, inspection of visible moving parts, lubrication, and repair or replacement of parts whose condition might interfere with the efficient operation of the equipment. During-operation maintenance is performed by the railway operating company, the balance is performed by the railway equipment maintenance company.

(2) Direct support maintenance is performed by the mobile railway workshop in the forward area and by the railway equipment maintenance company in the rear areas. When the repairs are not too extensive, the locomotive is repaired and put back into service. If the repairs are beyond the capabilities of the railway workshop, only those repairs will be made that are necessary to move the locomotive to a fixed installation for repair.

(3) General support maintenance and limited depot maintenance are performed by the diesel-electric locomotive repair company.

(4) There are no units provided in the transportation railway service for the performance of full depot maintenance. This category of maintenance beyond the capabilities of the railway car repair company and diesel-electric locomotive repair company is normally provided by a civilian facility.

c. *Rolling Stock.*

(1) Normally the railway battalion's train maintenance sections and crews perform organizational and direct support maintenance; this includes running repairs and inspection of rolling stock. The supply and railway repair car companies are responsible for general support and limited depot maintenance.

(2) Organizational maintenance is performed at the originating point of the train and at inspection points en route by military car inspectors or civilian railroad personnel. It consists of making running repairs required for the safe operation of the train.

(3) Direct support maintenance is performed by maintenance personnel, either military or civilian, at the home terminals of the

cars or at a prescribed location. It consists of running and emergency repairs that necessitate taking the car out of service for a short time. (See TM 55-203.)

(4) Repair track installations (rip tracks) normally are set up at main terminals. Usually they are also necessary at other points on the division, such as function points or heavy loading centers, to take care of repairs that cannot be made at the loading installation and to avoid moving the cars into the main terminal. The master mechanic (railway equipment company commander) is responsible for the operation of the repair-track installation.

4-41. Inspection and Maintenance of Locomotives

a. Basic Principles.

(1) Suitable inspection pits and facilities must be provided for inspection, repair, and adjustment of parts.

(2) The engineman is responsible for the equipment he operates.

(3) The fireman is responsible for maintaining the proper water level and steam pressure on steam locomotives. He receives instructions from the engineman, his immediate superior.

(4) Each locomotive must be inspected daily, or at the end of each trip, and DA Form 55-226 must be completed for steam locomotives; DD Form 862 for diesel-electric locomotives.

(5) Each locomotive must be inspected monthly and DA Form 55-227 completed for steam locomotives; DD Form 1336 for diesel-electric locomotives.

(6) In addition to the daily and monthly inspections, each locomotive must be inspected quarterly, semiannually, and annually. Maintenance documentation will be in accordance with TM 38-750.

b. Enginehouses. The two general types of enginehouses are turnaround and maintenance. The turnaround enginehouse is small and is only equipped with facilities for performing

minor repairs and services. Work done in this enginehouse usually requires only 1½ to 3 hours. The maintenance enginehouse has facilities for making major as well as minor repairs; here the division locomotives are maintained in good operating condition and kept at maximum availability. TM 55-201 (steam locomotives) and TM 55-202 (diesel-electric locomotives) are general references covering maintenance procedures at enginehouses.

4-42. Maintenance-of-Way

a. Roadway. Roadway maintenance is the care taken and work performed to keep that part of the right-of-way on which the track is constructed in good condition. Right-of-way includes excavations, embankments, slopes, shoulders, ditches, and diversions of roads and streams.

b. Track. In a theater of operations, the track must be maintained in operable condition at all times. The four primary considerations in track maintenance are gage, surface, alinement, and dress. The roadbed and track must be inspected frequently to avoid delays in operation resulting from damage caused by sabotage, direct enemy action, or weather.

c. Structures. In a theater of operations, the structures essential to the railway operation must be maintained in accordance with the standard maintenance prescribed. Structures include bridges, culverts, tunnels, and fueling and watering facilities. When repairing structures, minimum clearances must be observed at all times.

d. Distortion. The continual passing of trains around a curve eventually moves the track, which disturbs alinement and distorts the curve. The track should be restored to its correct curvature after determining if any distortion exists. This should be done by TRS maintenance-of-way personnel. A field expedient for determining the curvature of a track is the string method (para 4-44).

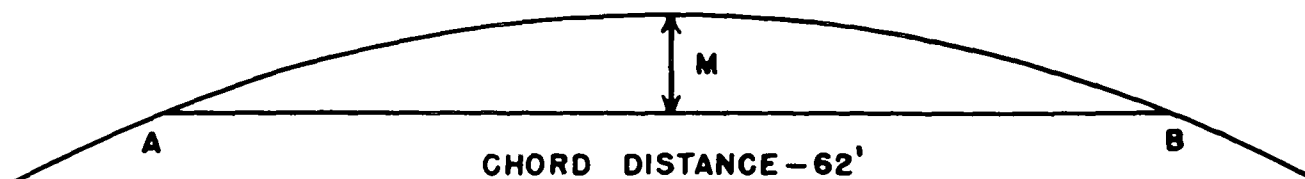


Figure 4-19. Determination of degree of curvature, using the string method.

4-43. Degree of Curvature and Curve Radius

The table below shows relationships between degree of curvature and radius of curvature for simple curves. Degree of curvature means the degrees of central angle subtended by a 100-foot (30.48-meter) chord. Radius of curvature is the distance from the apex of the central angle out to the curve. The degree of curvature and radius of curvature form the sector of a circle; the area of this sector may be expressed in either of the following ways—

$$\begin{aligned} \text{Area} &= \frac{R \times \text{arc}}{2} \\ &= \frac{3.1416 \times R^2 \times D}{360} \end{aligned}$$

Equating the two expressions above, $R =$

$$\begin{aligned} &\frac{\text{arc} \times 360}{2 \times 3.1416 \times D} \\ &= \frac{\text{arc} \times 57.3}{D} \end{aligned}$$

where

R = radius of curvature in feet

D = degree of curvature in degrees

For a 1° curve, the arc and chord are almost the same. Therefore, for practical purposes the arc in the formula for R above can be called a 100-foot chord for a C value of 1° . R then

equals 5730 for a 1° curve, and $\frac{5730}{D}$ for a D -degree curve.

D	R	D	R	D	R
1	5730	8	716	15	382
2	2865	9	637	16	358
3	1910	10	573	17	337
4	1433	11	521	18	318
5	1146	12	478		
6	955	13	441		
7	819	14	409		

4-44. Determining Curvature by String Method

(fig. 4-19)

If a surveying instrument is not available, the degree of simple curvature (arc of a circle) of a track may be computed by the string method. Although this method is not exact because of the uncertainty of how much the string has stretched, the degree of error is insignificant. To determine the degree of curvature of a track by the string method—

a. Select a portion of track well within the main body of the curve.

b. Measure a chord distance of 62 feet (18.897 meters) along the inside (five-eighths of an inch down from the top) of the high rail (A to B, fig. 4-19).

c. Stretch a string or strong cord very tightly between points A and B, and measure the distance M at the midpoint of the cord. The distance in inches is approximately equal to the degree of curvature. In the example shown in figure 4-19, if M is 5 inches, the degree of curvature is 5° . (As a curve gets sharper, the distance M increases.)

4-45. Railway Supply

a. Railway supplies, as distinguished from organizational supplies, are expendable supplies required for the operation and maintenance of railway divisions.

b. Whenever possible, local sources of supply should be used to ease transportation requirements. In a theater of operations, supplies may be procured from military stocks, manufacturers that are in or near the theater, foreign railways, captured enemy material and equipment, parts and assemblies manufactured

or repaired by the railway battalion, and transfers from other railway operation units.

c. All operating units must submit reports of supplies on hand at the beginning of operations to facilitate supply control.

d. The battalion supply officer serves as fuel agent for the railway transportation battalion; he is responsible for the operating agencies of the transportation railway service receiving sufficient locomotive fuel—regardless of source. Requisitions for fuel and lubricants are made through normal supply channels.

e. Tables of allowances and supplies are prepared by the supply officer of the highest transportation railway echelon for all units within the command. A workable stock level allowance must be determined for each unit to insure uninterrupted operation at all times. Normally, stock levels for the railway division are determined from past requirements.

f. An estimate of spare parts requirements may be made by using the factor of 1.5 short tons per month for each train per day moving in either direction. Beginning with the first railway division, select the train density established for the division, and multiply by 2 (for two-way travel); then multiply this result by 1.5, which equals the total amount in short tons of spare parts required per month for this specific division. Continue this process for each successive division to determine the grand total of short tons required per month for the entire railway. This is an estimate only. Revisions are necessary based on operating conditions.

4-46. Supply Request Procedure

a. The normal procedure for requesting a Transportation Corps item of supply is as follows. The company commander submits a request to the battalion supply officer. The battalion supply officer consolidates requests, makes lateral transfers of transportation supplies when necessary, prepares a formal request, and forwards it to the railway group supply officer. The supply officer of the railway

group determines if the item or items requested are available in one of the other units assigned to the railway group. The item or items are transferred if they are available; if they are not available, the request is processed and forwarded to the assistant general manager, supply (G4). The assistant general manager, supply, may then direct the transfer of the requested item or items from one railway group to another. If the items cannot be obtained from another railway group, he passes the request to the transportation depot company for issue.

b. When the railway group is the highest echelon of the transportation railway service in the theater, the group supply officer discharges the responsibilities of the assistant general manager, supply. When the railway battalion is not operating as a part of a railway group, the battalion supply officer is authorized to handle supply matters directly with supply agencies. The highest transportation railway service headquarters in the theater may authorize the battalion supply officer to request certain transportation items of routine supply directly from the appropriate supply depot without the approval of the next higher echelon. Items in short supply may be controlled as necessary, depending on the stock level in the depot. The battalion supply officer may be permitted, by the same headquarters, to request routine items from the depots of the other technical services.

c. To obtain supplies from outside sources—industry, railway stocks, and railway supply channels—the battalion supply officer prepares purchase orders or requests in accordance with the policy established in the particular theater. Normally, purchase orders or requisitions are forwarded to the railway group supply officer for further action; however, the railway battalion commander may be delegated the authority to approve purchase order and requisitions for specified quantities of particular supplies. In such cases, the battalion procures the supplies locally and sends information copies of the transaction to the railway group supply officer. When the company commander is au-

thorized to make local purchases, information copies of each transaction must be sent to the battalion supply officer. It is essential that accurate records be maintained of all transac-

tions in order to protect the U.S. Government from fraudulent claims.

d. All captured enemy material and equipment must be recorded and accounted for.

CHAPTER 1

GENERAL

1-1. Purpose and Scope

a. This manual is both a planning guide for staff and unit officers and a digest of operational data for use as a reference by operators and users of transportation when unit or staff libraries are not readily available.

b. This manual does not include policies and procedures governing the mode selections for commercial CONUS transportation or the use of Government Bills of Lading. For the assignment of routing authority, see paragraphs 202012 and 202013, (AR 55-355); for the preparation and/or use of the Government Bills of Lading, see paragraphs 214009 and 214016, (AR 55-355).

c. This manual includes characteristics of typical transportation equipment and facilities and methods for estimating the capabilities of, or requirements for, transportation equipment, facilities, and troop units. Personnel and equipment data for the modes of transportation and for transportation terminals are presented as well as data for computing requirements for staff, supervisory, and control activities. Factors concerning administrative support requirements are included. It also contains report formats and examples of orders and standing

operating procedures. Loading data for water, rail, motor, and air movements; tables on weights, measures, and conversion factors; and miscellaneous data of general usefulness are included.

d. Planning data contained herein should be modified as necessary to reflect known conditions and requirements. Current data should be used when available rather than that contained in this reference. Information contained in various chapters does not necessarily reflect current tables of organization and equipment.

1-2. Application

The material presented herein is applicable to nuclear and nonnuclear warfare.

1-3. Changes and Revision

Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the Commandant, U.S. Army Transportation School, Fort Eustis, Virginia 23604.



CHAPTER 2

AIR

Section I. ORGANIZATION

2-1. Organization

<i>Unit</i>	<i>TOE</i>	<i>Mission and/or capability</i>	<i>Assignment</i>
Light airmobile company, aviation battalion, airborne division.	1-57	To provide tactical air movement of combat troops in airmobile operations. To provide tactical air movement of combat supplies and equipment in airmobile operations.	Organic to aviation battalion, airborne division, TOE 1-55.
Airmobile company (light), aviation battalion, infantry division, or aviation company (airmobile).	1-77	To provide tactical air movement of combat troops in airmobile operations. To provide tactical air movement of combat supplies and equipment within the combat zone.	Aviation battalion, infantry division, TOE 1-75. As required when organized as separate company.
Headquarters and headquarters company, aviation battalion.	1-256	To provide command control, staff planning, and administrative supervision for 3 to 7 transport aircraft companies.	To the field army or corps aviation group when the primary mission is tactical support. To the field army support command aviation group when the primary mission is logistical support.
Aviation medium helicopter company.	1-258	To provide air transport of personnel and cargo for combat service support and combat support operations.	To the field army, theater army support command, or other commands as required. Normally attached to headquarters and headquarters company, aviation battalion, TOE 1-256.
Aviation heavy helicopter company.	1-259	To provide combat service support airlift for movement of heavy supplies, vehicles, aircraft, and equipment and, as directed, provide combat support airlift of combat units and air supply of units engaged in combat operations.	To an aviation group, TOE 1-252. Normally attached to headquarters and headquarters company, aviation battalion, TOE 1-256.
Headquarters and headquarters detachment, transportation movement control center.	55-6	To plan and program nontactical movements of personnel, materiel, and supplies (except bulk POL) within the field army area, other than those between general support/direct support groups and their supported units. To maintain liaison, as required, with transportation elements of other component U.S. Forces and with allied and host nation transportation agencies.	To a field army support command. Normally attached to a headquarters and headquarters company, transportation brigade, TOE 55-62.
Headquarters and headquarters company, transportation brigade.	55-62	To command and control air transport, motor transport, terminal transfer, and transportation movements units.	To a field army support command.

<i>Unit</i>	<i>TOE</i>	<i>Mission and/or capability</i>	<i>Assignment</i>
Headquarters and headquarters detachment, transportation airlift maintenance and supply battalion.	55-66	To provide the command and staff, and administration, supply, and communications for the transportation aircraft maintenance and supply general support battalion. To provide repair parts general support for aircraft and aircraft armament peculiar items for the field army.	To a field army support command or a logistical command.
Transportation maintenance company, maintenance battalion, infantry division.	55-89	To provide direct support aircraft maintenance capability as an integral part of the support command of the infantry division.	Organic to maintenance battalion, infantry division, TOE 29-15.
Transportation aircraft maintenance company, maintenance battalion, airborne division.	55-99	To provide direct support aircraft maintenance capability as an integral part of the support command of the airborne division.	Organic to maintenance battalion, airborne division.
Transportation aircraft maintenance and supply battalion, airmobile division.	55-405	To provide aircraft direct support maintenance, including avionics and armament maintenance, and repair parts support for aircraft organic to an airmobile division.	Organic to support command, airmobile division, TOE 29-41.
Transportation maintenance and supply company, transportation aircraft maintenance and supply battalion, airmobile division.	55-407	To provide aircraft direct support maintenance, including avionics and aircraft armament maintenance, and repair parts support for aircraft organic to an airmobile division.	Organic to transportation aircraft maintenance and supply battalion, airmobile division, TOE 55-405.
Transportation aircraft maintenance company, armored and infantry (mechanized) division.	55-424	To provide direct support aircraft maintenance capability as an integral part of the support command of the armored division or infantry division (mechanized).	Organic to maintenance battalion, infantry division (mechanized), TOE 29-25, or maintenance battalion, armored division, TOE 29-35.
Transportation aircraft direct support company.	55-457	To perform direct support maintenance on Army aircraft, aircraft armament, limited maintenance on avionics, equipment, and related supply and recovery support to nondivisional aviation units.	To a field army or corps or a logistical command.
Transportation aircraft maintenance general support company.	55-458	To perform general support and back up direct support maintenance on Army aircraft and aircraft armament and back up direct support maintenance on avionics equipment.	To a field army support command, corps support brigade, or a logistical command. Normally attached to an aircraft maintenance and supply battalion (general support).
Transportation helicopter teams and aircraft field maintenance teams.*	55-500	To provide personnel and equipment to supplement TOE units where additional trained personnel are required in numbers less than TOE strength, to perform transportation functions as part of a larger unit where the need for the activity is less than a similar TOE unit and to operate as a separate organization where no TOE unit is provided.	Teams may be attached or assigned to higher echelon units or may be organized into service units to perform functions as required by existing conditions.

*See TOE 55-500 for additional teams.

Section II. AIRCRAFT

2-2. Army Aircraft

a. Mission Planning. All planning beyond the preliminary stage should be coordinated with, or accomplished by, the aviation officer, the local operations officer, and the aviator designated to fly the mission. Some variables which are not discussed below but which must be considered in planning each mission are the proficiency of aviators and other operating personnel, the effects of cargo loading and fuel burn-off on the center of gravity (CG) of the aircraft, condition of runways, approaches to airfields, and navigation aids available for instrument approaches and landings during bad-weather operations. The conditions and criteria set forth in this manual are useful only for preliminary or general planning; they cannot and must not be used for specific mission planning. Detailed aircraft performance data and limitations under varying air density and temperature conditions, power settings, and cargo loading are set forth in the TM 10-series pertaining to the specific aircraft.

b. Variables Affecting Performance. Some of the common variables affecting the performance standards of the aircraft are discussed in (1) through (6) below.

(1) *Air density and temperature.* The ability of the aircraft to lift weight is directly proportional to the density of the air mass in which it is operating; the density of the air mass is affected by, and is inversely proportional to, the temperature, humidity, and altitude above sea level. For example, the U-8F (Seminole), weighing 7,700 pounds and operating from a point at sea level where the temperature is 59° F. (15° C.), requires 2,200 feet from the start of its takeoff run to clear a 50-foot obstacle. The same aircraft, operating at the same weight from an airport 5,000 feet above sea level where the temperature is 95° F. (35° C.), requires over 2,985 feet to clear a 50-foot obstacle. The capability of a helicopter with an externally slung load can be reduced as much as 80 percent between sea level at 0° F. and 6,000 feet at 95° F.

(2) *Range and payload.* Range and pay-

load capabilities outlined in this chapter are based on a sea-level takeoff in a standard atmosphere as defined by the International Civil Aeronautics Organization. The ICAO defines standard atmosphere as a dry air condition of 29.92 inches of mercury (Hg) pressure and 59° F. (15° C.) temperature.

(3) *Wind.* Surface wind affects both fixed-wing and rotary-wing aircraft. In computations in this manual, the surface-wind velocity is assumed to be zero or negligible. If utilized in conjunction with available runways, a surface wind has a pronounced beneficial effect on the takeoff and landing characteristics of an aircraft, since lift capability is directly proportional to the speed of the air past the lifting surfaces.

(4) *Speed.* Within the range of speeds in which a particular aircraft can fly, it can be said generally (except for turbine-powered aircraft) that the slower the speed, the longer the range for available fuel. A fixed-wing aircraft flying about 20 percent faster than its minimum speed can fly farther than it can at its maximum speed. This same principle applies in a general sense to helicopters. However, since helicopters have no minimum forward speed, the best range is usually determined as some percentage of the maximum forward speed.

(5) *Altitude.* The amount of oxygen available in the air decreases as altitude increases. Flight above 10,000 feet for an extended period is extremely dangerous unless personnel are supplied with oxygen or unless the aircraft is pressurized so that the atmosphere within corresponds to a lower level. A minimum of 1,000 feet should be allowed for clearing obstacles; therefore, when the terrain altitude is over 9,000 feet, only aircraft supplied with oxygen should be programmed for flight. While oxygen supplies for the crew permit cargo flights above 10,000 feet, troop transport for extended periods is impractical without other provisions for oxygen.

(6) *Weather.* For weather to permit VFR (visual flight rules) flight, the underside of

the cloud ceiling should be at least 1,000 feet above the terrain for the entire route, and the visibility should be at least 3 miles in control zones around airfields and 1 mile outside control zones. All other weather is referred to as IFR (instrument flight rules). VFR aircraft normally cannot be flown in IFR weather. The availability of all-weather aircraft and qualified aviators does not always guarantee the start of a mission; an aviator may very well have to refuse to attempt a mission if extreme weather is anticipated. If air turbulence or other conditions are such that an aircraft cannot remain airborne, it is foolhardy to attempt a mission. The high speed and long range of modern aircraft require adequate weather intelligence for the entire route before the start of any mission. The weather to be encountered en route may not, and very frequently is not, apparent at the originating point.

c. Powerplants and Accessories. Powerplants used in Army aircraft are of several different types. As technological advances are made, it can be expected that powerplants and accessories other than those discussed in (1) through (4) below, will be added to the inventory.

(1) *Engine types.*

(a) *Turbojet.* This is a turbine type engine which utilizes the thrust of its exhaust gases for propulsive power. This engine is not currently used in any Army aircraft.

(b) *Turboshaft.* This engine is a double turbine type which utilizes the thrust of its exhaust gases to drive a second or power turbine. The energy imparted to the power turbine is, in turn, transferred to a rotating shaft. This type of engine is used in Army helicopters to drive the rotors through gear reductions.

(c) *Turboprop.* This engine is identical in principle to the turboshaft engine, but the power is imparted to a propeller through a gear reduction.

(d) *Reciprocating.* This is a conventional engine having aircraft, automobile, and marine applications. Aircraft reciprocating engines are divided into several types and classes. The type is determined by the engine's

shape and cylinder arrangement. The two classes are air cooled and liquid cooled. At present, Army aircraft do not use liquid-cooled engines. The types of reciprocating air-cooled engines used in Army aircraft are—

1. *Opposed.* The cylinders are arranged in two rows opposite each other. In fixed-wing aircraft, the engine is usually mounted so that the length of the cylinder is parallel to the ground. All opposed engines used in Army aircraft have six cylinders.

2. *Radial.* The cylinders are arranged radially around a central crankshaft. These engines are classified as single-bank or multibank. Single-bank engines always have an odd number of cylinders. Multibank engines are essentially two single-bank engines mounted back to back on a common crankshaft. Army aircraft employ both types of radial engines.

3. *Supercharged.* Reciprocating engines may be modified by superchargers which serve two purposes. They enable engines to develop more horsepower per unit of weight by increasing the quantity of combustible mixture that can be induced into each cylinder. They also permit engine operation at higher altitudes by compressing the rarefied air to a usable pressure prior to induction into the cylinders. Except for the smallest reconnaissance types, all Army aircraft that use reciprocating engines have superchargers.

(2) *Weight and power.* Because weight is such a critical factor, aircraft engines are engineered to give the most possible power per pound of weight. To permit rapid acceleration during takeoff (the most dangerous stage of flight), engines are designed to operate for short periods of time at power outputs that would be self-destructive if continued for long periods. For most aircraft engines, this period of excessive power is limited to 5 minutes during any one application. The power ratings of engines used in Army aircraft usually are referred to as one of the following:

(a) *Takeoff horsepower.* This is the maximum horsepower an engine can develop for a period of 5 minutes or less without immediate damage. Some engines, when operated at the lower altitudes, can exceed this horse-

power output. This power, misused, can destroy an expensive engine; it is one of the many reasons for extensive training of aircraft operating personnel.

(b) *METO horsepower*. This is the maximum horsepower that an engine can develop continuously. (The term METO is derived from the words "maximum, except take-off.")

(c) *Cruise horsepower*. This is the horsepower which gives the best speed with minimum engine wear and delivers the best flight characteristics with respect to flight attitude, control response, and minimum vibration.

(3) *Propellers*. The propellers used on Army fixed-wing aircraft fall into three categories.

(a) *Fixed pitch*. This is a one-piece, metal propeller used on 0-1 aircraft. The pitch or angle of bite of the propeller blades is fixed and cannot be changed.

(b) *Constant speed*. This propeller consists of two or three blades and a hub. The hub is designed to permit the blades to change their pitch angle as necessary to maintain a constant engine speed. The desired engine speed is set by the aviator; it is maintained by a governor which transmits its commands to the propeller hub by means of hydraulic pressure, using the engine lubricating oil as a medium.

(c) *Full feathering*. This is a constant speed propeller which can be set for a maximum degree of pitch. This enables the aviator to reduce propeller drag to a minimum when one engine of a multiengine aircraft is inoperative. (The Army uses full feathering propellers on multiengine aircraft only.)

(4) *Rotors*. The rotor blades used on Army rotary-wing aircraft vary in design and construction, depending on the manufacturer and the desired speed and gross weight of the aircraft. The pitch angle or bite of the blades on all rotary-wing aircraft can be controlled by the aviator. The control mechanism, which is part of the flight control system of the aircraft, is peculiar to the aircraft and is not a property of the rotor blade itself.

d. Aircraft Balance and Range.

(1) *Center of gravity (CG)*. The center of gravity of an aircraft is an important factor in flight characteristics and safety. It must be computed by trained personnel for each aircraft for each flight. (Center of gravity locations given in this manual are from design data and should be used as guides only.) The computation includes more than the takeoff configuration of the aircraft; it must also consider the progressive change of the center of gravity as fuel is consumed in flight. An aircraft could be loaded so that it would be completely safe at takeoff, but be enough out of balance at the end of the mission that the aviator could lose control, especially during letdown or landing. Each aircraft varies in weight and balance from other aircraft, even of the same type, model, and series. The actual basic weight and center of gravity of each must be known before center of gravity changes due to load and fuel can be computed.

(2) *Linear measurements*. Linear measurements of cargo compartments are usually expressed in inches. For fore and aft measurements, the locations are referred to as stations. The station points are used in computing the fore and aft CG of the aircraft; all stations are computed as having a plus factor. Station zero (reference datum line) on most aircraft is usually at the nose of the aircraft or at an imaginary point in front of the aircraft. To eliminate the possibility of having to use negative station factors in the future, the imaginary location of the aircraft is set by the designers as the most forward position to which future modifications can reasonably be expected to extend.

(3) Operating distances and fuel load.

(a) *Range*. For the purposes of this manual, unless otherwise noted, range is the one-way distance that an aircraft can fly with the stipulated load, without refueling, based on the following assumptions:

1. Takeoff altitude is sea level.
2. Flight altitude for the mission is 5,000 feet.
3. Wind condition at altitude is zero.
4. Fuel reserve on arrival at destination is 20 minutes for VFR and IFR flights.

5. Fuel allowances are made for taxi, runup, takeoff, and climb-out to altitude.

(b) *Radius of action.* Radius of action, or radius, is the maximum distance that an aircraft can fly with payload to a destination and return empty without refueling, unless otherwise specified (return fully or partially loaded). Reserve conditions for this type of mission are the same as in (a)4 above. A further fuel allowance must be made for one additional runup, taxi, takeoff, and climb-out.

e. Considerations Peculiar to Helicopters.

(1) *"In-ground effect" takeoff.* The flight characteristics of the helicopter are affected by the high pressure region or "ground cushion" between the helicopter and the ground. This cushion, created by the downward displacement of air through the rotor blades, is effective to a height of approximately one-half the rotor diameter and increases the lift capability of the helicopter. The use of this takeoff technique increases safety and decreases wear on the engine, power train, and associated equipment. It requires horizontal flight near the ground until sufficient speed is attained for safe flight.

(2) *"Out-of-ground effect" takeoff.* When this vertical takeoff method is used, the ground cushion is lost almost immediately after lift-off (height of one-half the rotor diameter). Usually this takeoff method is employed when a sling load is to be lifted or when the takeoff area is too restricted to permit a ground run or low-level flight. When possible, other methods should be used since payload is reduced and certain risks are involved in this technique. The lift capability, or power, which the engine can develop at maximum continuous power in a vertical takeoff is never equal to the lift capability of the helicopter under forward flight using normal cruise power. If the engine fails above the ground cushion before

altitude or forward speed permits autorotational landing, the helicopter may be destroyed or seriously damaged.

(3) *"Ground run" takeoff.* This type of takeoff employs the same technique used for fixed-wing aircraft and involves a run over the ground until sufficient speed is attained for safe flight. It is employed when the altitude, temperature, or aircraft weight (or a combination of these factors) is such that the aircraft cannot hover close to the ground.

f. Transportability. For disassembly, crating, and crated and uncrated shipment of Army aircraft, see appropriate technical manuals for the aircraft, including manuals of the TM 55-450-series and FM 101-10.

2-3. Army Aircraft Payload Versus Range

a. General. Payload is the number of passengers and/or the amount of cargo that an aircraft can carry, usually expressed in pounds. As the distance to be flown is increased, the fuel required is increased and the payload is decreased. The payload varies with changes in altitude, temperature, air pressure, humidity, and wind.

b. Computations for Range Versus Payload. Payload for various ranges may be closely approximated for Army aircraft by using figure 2-1, which has been constructed from computations for 50, 100, and 200 nautical miles shown in the table in *c* below. In computing total payload for the mileages shown, the maximum payload possible is used. Pounds of fuel not required to fly the mission have been replaced with payload. Figure 2-1 is a rapid reference that should be used for general planning only. When planning cargo operations over distances greater than 200 nautical miles, see the appropriate -10 technical manual for detailed planning information.

c. Army Aircraft Characteristics (figs. 2-1—2-29).

	O-1A, E (Bird Dog) Observation	OV-1A (Mohawk) Observation	OV-1B (Mohawk) Observation	OV-1C (Mohawk) Observation	U-1A (Otter) Utility	U-6A (Beaver) Utility	U-3D (Seminole) Utility	U-3F (Seminole) Utility	OH-6A Observation	OH-13H (Sioux) Observation	OH-23D (Raven) Observation	UH-1A (Iroquois) Utility	UH-1B * (Iroquois) Utility	UH-1D * (Iroquois) Utility	UH-19D (Chickasaw) Utility	CH-53C (Shawnee) Cargo	CH-34C (Choctaw) Cargo	CH-37B (Mohave) Cargo	CH-47A (Chinook) Cargo	CH-54 ^b (Sky Crane) Cargo	MQM-57A (Drone)
	1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3	2	0
Crew (200 lbs ea)																					
Dimensions:																					
Length—fuselage	25'9½"	41'1"	43'8"	41'1"	41'10"	30'5"	31'6"	33'4"	23'6"	30'5"	28'5"	36'6"	39'6"	41'11"	42'3"	52'7"	46'9"	64'11"	51'0"	70'3"	13'4"
Length—blades unfolded	NA	NA	NA	NA	NA	NA	NA	NA	30'2¼"	41'5"	40'8"	52'10"	52'11"	57'1"	62'3"	86'4"	65'10"	88'0"	98'3.25"	88'	NA
Length—blades folded	NA	NA	NA	NA	NA	NA	NA	NA	23'6"	NA	NA	NA	NA	NA	42'3"	52'7"	37'0"	55'8"	51'0"	70'3"	NA
Width—blades folded	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11'7"	14'0"	13'0"	27'4"	12'5"	21'10"	NA
Width—tread	7'7"	9'2"	9'2"	9'2"	11'2"	10'2"	12'9"	12'9"	6'3"	7'6"	7'6"	8'4"	8'4"	8'6"	11'0"	13'4"	12'0"	19'9"	11'11"	19'9"	NA
Height extreme	7'6"	13'	13'	13'	12'5"	10'5"	11'4"	14'2"	8'4½"	9'6"	10'1½"	11'5"	13'2½"	13'1"	15'3"	15'9"	15'11"	22'0"	17'11"	24'10"	2'6"
Diameter main rotor	NA	NA	NA	NA	NA	NA	NA	NA	26'4"	35'2"	35'5"	43'9"	44'0"	48'3.2"	53'0"	44'0"	56'0"	72'0"	59'1.25"	72'	NA
Diameter tail rotor	NA	NA	NA	NA	NA	NA	NA	NA	4'3"	5'8"	5'6"	8'5"	8'6"	8'6"	8'9"	NA	9'6"	15'0"	NA	16'0"	NA
Wingspan	36'0"	42'0"	48'0"	42'0"	58'0"	48'0"	45'3"	45'10½"	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11'5" 13'4"
Cargo door:																					
Dimensions—width/height (in.)	45×33	NA	NA	NA	46×45 left	40×40	35×36.5	50½×26½	26½×40½ left	NA	NA	48×48	48×48	92×49	48×48	45×59 cargo-left	53×48	nose 87×72 hatch 72×48	90×78	NA	NA
Location—side of fuselage (in.)	right	NA	NA	NA	30×42 right	left & right	right	left	34½×40½ right	NA	NA	left & right	left & right	left & right	right	37×59 rescue-right	right	72×72 right	rear	NA	NA
Cargo compartment:																					
Height of floor above ground (in.)	NA	NA	NA	NA	46	46	NA	48	25.25	NA	NA	26	27	32	30	38	34	36	30	NA	NA
Length usable (in.)	NA	NA	NA	NA	156	92	50.5	110.6	46	NA	NA	48	60	92	120	240	163.5	364	366	NA	NA
Width floor (in.)	NA	NA	NA	NA	60	48	53.6	55.0	50.5	NA	NA	80.5	80.5	96	66	46	60	87	90	NA	NA
Height (clear of obstructions) (in.)	NA	NA	NA	NA	52	51	46.7	55.0	48.5	NA	NA	56	56	52	60	66	70	69	78	112	NA
Cargo space optimum (cu-ft)	NA	NA	NA	NA	293	125	136	168.8	38	NA	NA	140	140	220	300	422	363	1,252	1,487	NA	NA
External cargo ^c :																					
Maximum hook or sling capacity (lb)	500	4,000	4,000	4,000	NA	1,000	NA	NA	NA	NA	NA	3,000	4,000	4,000	2,000	5,000	5,000	10,000	16,000	20,760	NA
Rescue hoist capacity (lb)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	400 or 600 ^d	400	600	600	600	NA	NA
Cargo loading winch capacity (lb)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,000	3,000	NA	NA
Passenger capacity:																					
No. of troop seats (240 lb per man)	1	0	0	0	10	5	5	5	3	1	2	6	8	12	6	12	12 or 18	23	33	NA	NA
No. of litters and ambulatory	0+1	NA	NA	NA	6+3	2+2	0+5	0+5	0+3	2+0	2+1	2+1	3+1	6+1	6+0	12+0	8+0	24+0	24+3	NA	NA
Operational characteristics ^{e,f} :																					
Maximum allowable gross weight (lb) ^g	2,100 (O-1A) 2,165 (O-1E)	12,500	13,318	12,676	8,000	5,100	7,300	7,700	2,700	2,450	2,700	7,200	8,500	9,600	7,900	13,500	13,600	31,000	33,000	42,000	466
Basic weight (lb) ^g	1,502 (O-1A) 1,614 (O-1E)	9,673	10,650	10,004	4,900	3,100	5,000	5,490	1,080	1,715	1,821	4,020 ^h	4,600 ^h	4,900 ^h	5,650	8,900	7,800	21,500	17,200	19,300	414
Useful load (lb) ^h	598 (O-1A) 551 (O-1E)	2,827	2,668	2,672	3,100	2,000	2,300	2,210	1,620	735	879	3,180	3,900	4,700	2,250	4,600	5,800	9,500	15,800	22,700	52
Internal fuel capacity (lb/gal)	252/42	1,930/297	1,930/297	1,930/297	1,281/213.5	828/138	1,380/230	1,380/230	382/59	578/43	276/46	812/125	1,072/165	1,430/220	1,050/175	1,800/300	1,572/262	2,388/398	4,095/630	8,700/1,350	34/5.6
Normal cruising speed (knots) ⁱ	87	185	185	185	104	105	155	160	100	70	70	80	90	100	70	80	85	90	110	100	160
Endurance at cruising speed (hr, min) ^j	4+00	1+15	1+25	1+25	6+30	6+00	6+00	6+00	2+25	1+45	1+50	1+25	1+45	2+15	2+25	3+15	2+50	1+25	2+40	2+00	00+30 ^k
Grade of fuel (octane)	115/145	JP-4	JP-4	JP-4	115/145	115/145	115/145	115/145	JP-4	80/87 ^l	80/87 ^l	JP-4	JP-4	JP-4	115/145	115/145	115/145	115/145	JP-4	JP-4	115/145
Fuel consumption per hour (lb/gal.) ^m	54/9	1,105/170	1,105/170	1,105/170	180/30	132/22	204/34	204/34	130/20	102/17	102/17	422/65	487/75	487/75	360/60	480/80	456/76	1,200/200	1,300/200	3,460/532	60/10

DEFINITIONS: (TM 57-210.)

^a Basic weight for standard aircraft. (Weapons systems and components not included.)

^b Data subject to change, resulting from developmental testing.

^c Detailed weight computations and characteristics taken from current technical manuals on each aircraft.

^d UH-19D: Helicopters prior to serial No. 56-1519 are equipped with provisions for a 400-pound-capacity rescue hoist; subsequent helicopters are equipped with provisions for a 600-pound-capacity rescue hoist.

^e All data computed at standard conditions at sea level.

^f Maximum allowable gross weight: The maximum allowed total weight of the aircraft prior to takeoff; the "basic weight" of the aircraft plus the crew, personnel equipment, special devices, passengers/cargo, and usable fuel and oil. This is limited by structure, power available, or landing load.

^g Basic weight: The empty weight of an aircraft in its basic configuration, including all appointments, integral equipment, instrumentation, and trapped fuel and oil, but excludes passengers, cargo, crew, and fuel and oil.

^h Useful load: The load-carrying capability of an aircraft. It includes the payload, crew, and usable fuel

and oil required for the mission. Here it is the difference between "maximum allowable gross weight" and the "basic weight" as defined above. Thus, it is evident that a reduction of the fuel load will reduce the endurance and increase the payload. (The payload is the useful load less the crew, full oil, and the required fuel for the mission.) Full oil is required for all missions.

ⁱ Normal cruising speed: The true airspeed which an aircraft can normally be expected to maintain at some standard power setting below rated military power. This speed will vary with altitude.

Airspeeds and fuel consumptions will vary with gross weight, altitude, power settings, and aircraft. See appropriate operator's manual for correct airspeed.

^j Endurance at cruising speed: The time that an aircraft can remain airborne at normal cruising speed with fuel aboard without using the required fuel reserve. The data listed under "operational characteristics" are computed using full fuel minus a 30-minute reserve, except turboprop which requires 20 minutes reserve.

^k No fuel reserve required.

^l During mobilization, fuels will be 115/145 and JP-4.

^m Computed at maximum gross weight and at sea level.



2-4. U.S. Air Force Transport Aircraft Characteristics
(fig. 2-2)

	C-7A (Caribou)	C-46F (Commando)	C-47D (Sky Train)	C-54G (Sky Master)	C-87C (Strato- freighter)	C-87G (Strato- freighter)	C-118 (DC-6)	C-119G (Packet)	C-121C (Constellation)	C-121G (Super Con- stellation)	C-123B (Provider)	C-124A (Globemaster)	C-124C (Globemaster)	C-130A (Hercules)	C-130E (Hercules)	C-133A (Cargomaster)	C-133B (Cargomaster)	C-135A (Stratolifter)	C-135B (Stratolifter)	C-141 (Starlifter)
Operating wt (lb) cargo with 463 L equip.	18,475	31,000	18,000	39,000	83,460	92,400	64,500	43,500	80,900	79,900	36,000	113,000	116,000	69,047	76,000	129,000	129,000	112,700	117,500	140,000
Normal max. gr wt (lb) ^a	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	71,047	79,400	129,800	133,500	112,700	117,500	140,000
Emergency max. gr wt (lb) ^a	28,500	45,000	31,000	69,000	150,000	153,000	107,000	68,300	137,500	135,400	55,200	175,000	185,000	124,200	155,000	275,000	286,000	270,000	274,000	315,000
Max. landing wt (lb)	28,500	55,000	33,000	73,000	166,000	169,000	112,000	72,700	145,000	145,000	55,200	180,000	194,500	124,200	174,000	282,000	300,000	270,000	274,000	315,000
Emergency max. cargo payload (ACL) (lb) ^b	28,500	55,000	33,000	73,000	130,000	130,000	107,000	72,700	122,000	122,000	-----	168,000	168,000	124,200	130,000	245,000	250,500	200,000	200,000	257,000
Normal max. cargo payload (ACL) (lb) ^b	7,500	17,500	11,400	24,000	40,000	40,600	25,400	19,500	33,100	30,100	12,000	62,000	59,000	25,000	49,000	106,000	106,000	77,300	77,500	64,405
Emergency max. troop capacity (over water/over land)	7,500	16,000	7,500	13,000	27,000	35,600	18,700	12,000	27,100	25,100	-----	50,000	47,000	25,000	37,000	86,000	86,000	77,300	77,500	64,405
Normal max. troop capacity (over water/over land)	32	50	27	49	80	80	70	62	78	78	61	171	171	92	92	120	120	119	119	154
Litter capacity (no attendants)	32	32	27	49	56/56	56/56	70/70	62	78/78	78/78	61	160/171	160/171	78	60/78	10/10	10/10	80/119	80/119	120/154
Paratroops	20	24	24	36	54	54	54	35	44	44	50	127	127	70	70	N/A	N/A	44	72	72
Average cruise speed (knots)	26	N/A	27	N/A	N/A	N/A	N/A	42	N/A	N/A	N/A	112	112	64	64	N/A	N/A	N/A	N/A	123
Max. range (nautical mi)	150	148	146	161	210	212	218	154	223	223	138	202	203	280	280	260	270	459	459	423
ACL—max. cargo space limit (10# cubic ft), 463 L or pallet	975	1,500	1,000	2,000	2,520	2,520	3,080	1,500	2,700	2,740	1,200	3,810	3,620	2,200	3,540	3,390	3,565	5,415	6,640	4,800
Center of gravity limits % MAC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24,920	24,920	53,350	53,350	27,600	27,600	46,680
Center of gravity limits ARM	26.0-39.0	309.0-331.0	239.6-263.1	16.0-32.0	15.5-34.0	15.5-34.0	16.0-33.0	20.0-30.0	19.0-32.0	19.0-32.0	18.0-32.0	18.0-34.0	18.0-34.0	19.0-30.0	24.4-29.2	21.5-32.0	22.5-32.0	18.8-35.0	18.8-35.0	24.0-33.4
Restraint G factors:	341.41-357.11	309.0-331.0	239.6-263.1	381.0-407.0	513.0-540.0	513.0-540.0	426.0-448.0	318.0-335.0	661.0-684.0	661.0-684.0	324.3-343.9	550.0-588.0	550.0-588.0	519.0-0-537.0	526.9-535.1	794.0-824.0	794.0-824.0	832.0-871.0	832.0-871.0	922.7-947.0
Forward	8.0	8.0	8.0	8.0	8.0	8.0	8.0	4.5	6.0	6.0	8.0	3.0	3.0	8.0	8.0	3.0	3.0	8.0	8.0	8.0
Aft	2.0	1.5	1.5	1.29	1.5	1.5	1.29	1.5	1.5	1.5	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Side	1.5	1.5	1.5	1.00	1.5	1.5	1.00	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Vertical (up)	2.0	2.0	2.0	2.47	2.5	2.5	2.47	2.25	2.0	2.0	4.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Vertical (down)	--	4.5	4.5	2.47	2.5	2.5	2.47	2.25	4.5	4.5	4.5	2.0	2.0	4.5	4.5	2.0	2.0	2.0	2.0	2.0
Cargo doors:																				
Dimensions—with/height (in.)	73½x74	95.5x78.6	84.5x70.6	94.8x66.6	103.2x88.0	103.2x88.0	124.0x78.75	110.4x96	106.5x74.5	106.5x74.5	110.0x96.0	136.0x140.0	136.0x140.0	120.0x108.0	120.0x108.0	142.0x144.0	142.0x154.0	78.0x116.4	78.0x116.4	123.25x109.2
Location—side of fuselage	rear	left	left	left	rear	rear	aft left	rear	aft left	aft left	rear	fwd	fwd	rear	rear	rear	rear	fwd left	fwd left	rear
					left	left	fwd left	aft left	58.2x76.75	58.2x76.75	elevator well	elevator well	elevator well	87.0x72.0	87.0x72.0	105.6x99.6	105.6x99.6			
Cargo compartment:																				
Floor level to ground (in.)	45.6	96.0	56.5	108.0	112.0	112.0	106.0	48.0	fwd—135.3	fwd—135.3	33.5	156.0	156.0	39.0/45.0	39.0/41.0	50.0	50.0	117.0-138.0	117.0/138.0	50.0/57.0
Length usable (in.)	345	572.0	360.5	596.4	763.2	763.2	816.0	442.8	984.0	984.0	345.0	876.0	876.0	492.0 ^a	492.0 ^a	982.0 ^a	982.0 ^a	860.0	860.0	840.0 ^a
Width floor (in.)	81	117.6	88.8	103.2	105.6	105.6	104.0	109.2	121.0	121.0	110.0/155.0	135.0	135.0	123.0	123.0	142.0	142.0	129.0	129.0	123.0
Height clear (in.)	75	84.0	76.8	93.6	74.0	74.0	93.0	96.0	80.4	80.4	96.0/110.0	139.0	139.0	109.0	109.0	143.0	143.0	84.0	84.0	109.0
Ramp incline (degrees)	16	N/A	N/A	N/A	24	24	N/A	12	N/A	N/A	15	17	17	12.5	12.5	9	9	N/A	N/A	11
Typical logistical mission Payload/nautical miles	7,000/400	16,000/1,000	7,500/1,000	13,000/1,900	27,000/1,800	35,600/1,800	18,700/2,000	12,000/1,450	26,500-2,000	7,600-2,000	12,000/990	40,500/1,400	42,000-1,500	25,000/1,800	37,000/2,900	50,800/2,500	63,400/2,500	61,120/2,300	61,120-2,300	57,462/4,000

^a Maximum allowable gross weight: The maximum allowed total weight of the aircraft prior to takeoff—the basic weight of the aircraft plus the crew, personnel equipment, special devices, passenger/cargo, and usable fuel and oil. This is limited by structure, power available, or landing load.

^b Maximum allowable cabin loads (ACL) will vary with operating weight of aircraft. Aircraft gross takeoff weight that includes fuel, oil, water, flight personnel, and the logistical range mission determines the maximum allowable payload.

^c Emergency only.

^d Excludes ramp.

SOURCE: FM 55-15 Transportation Reference Data dtd Feb 68

Fig 2-2

RANGE

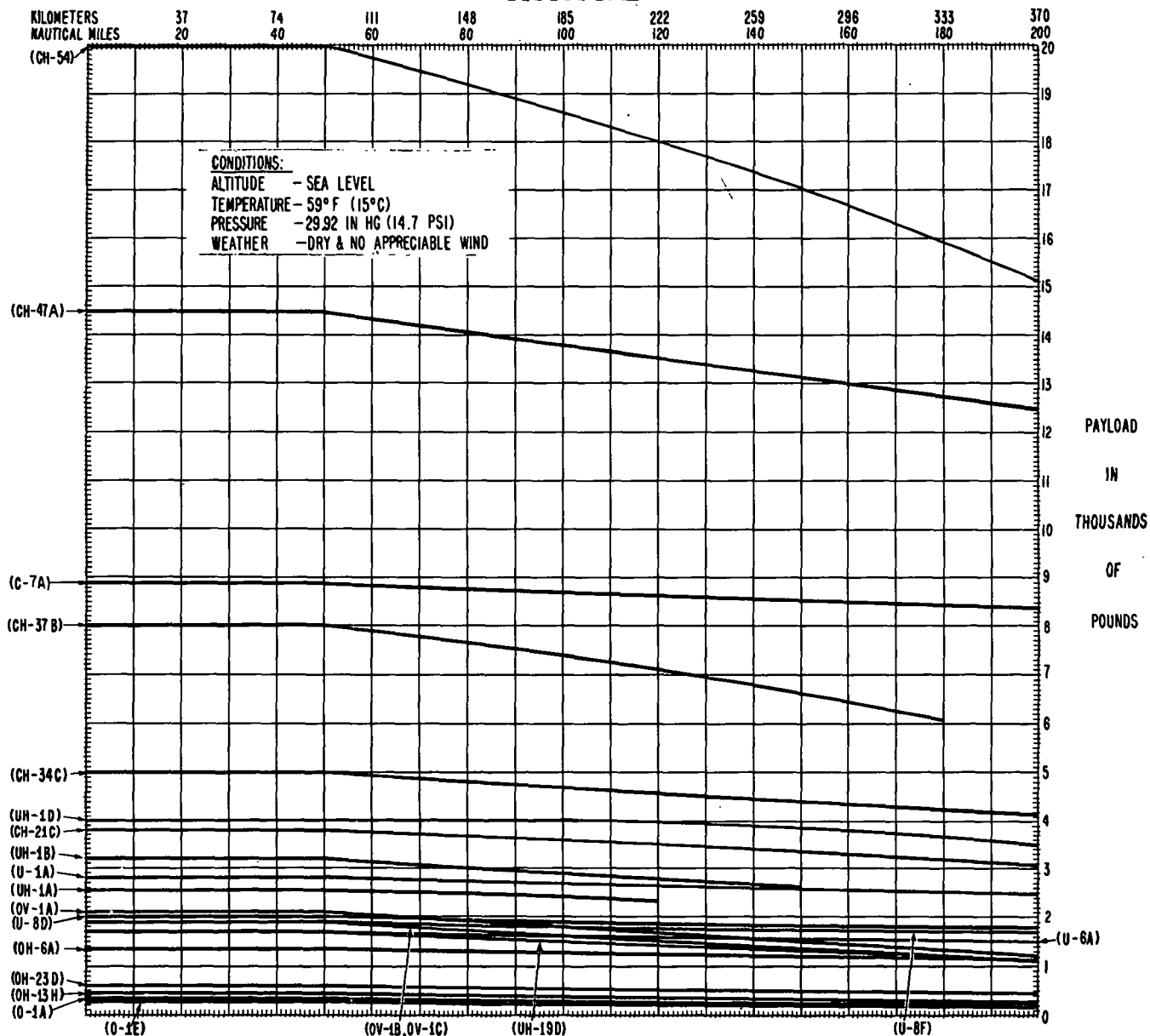


Figure 2-1. Payload versus range of Army aircraft.

CURRENT CARGO COMPARTMENT ENVELOPE AND ACCESS LIMITATIONS

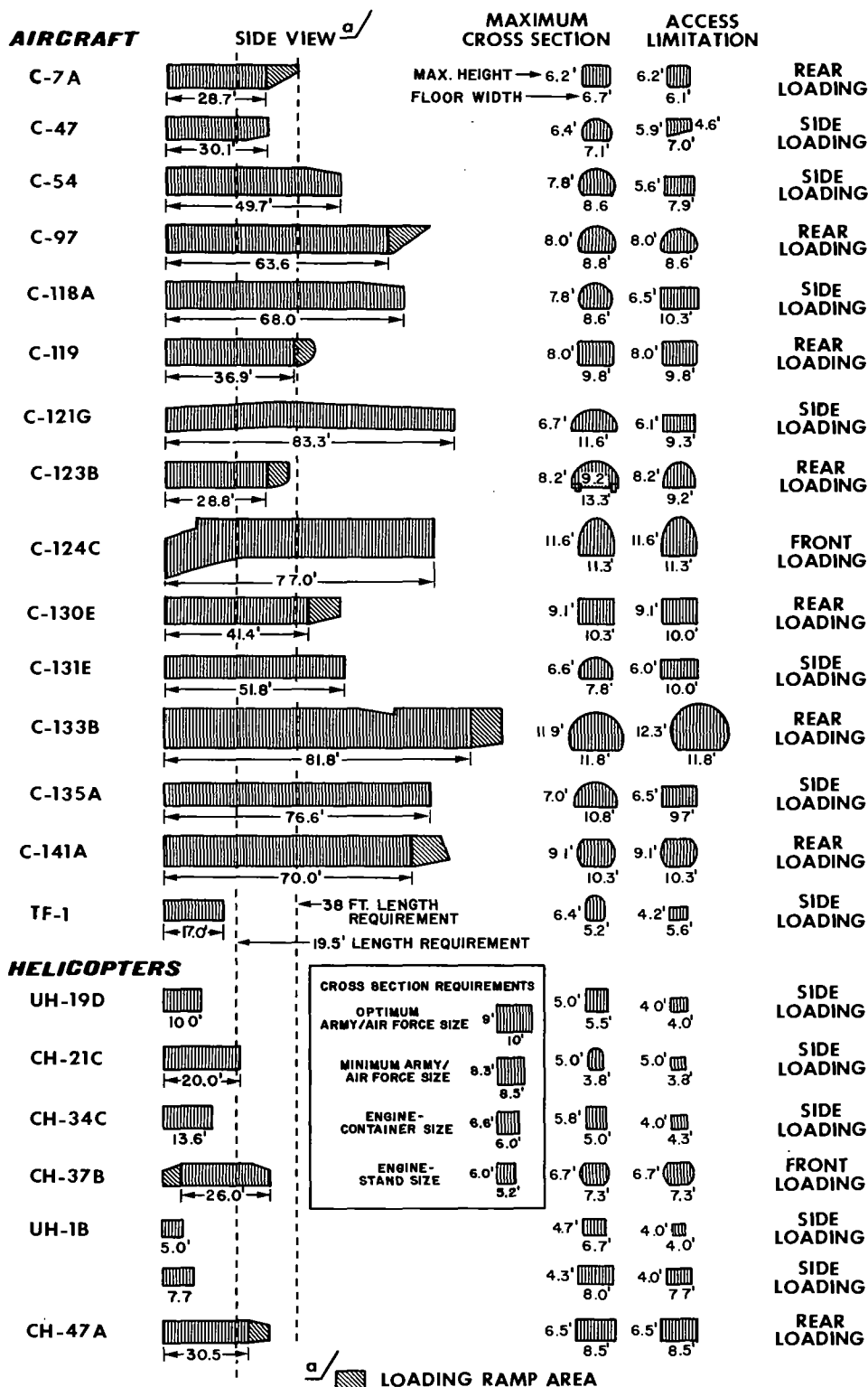


Figure 2-2. Cargo compartment envelope and access limitations.

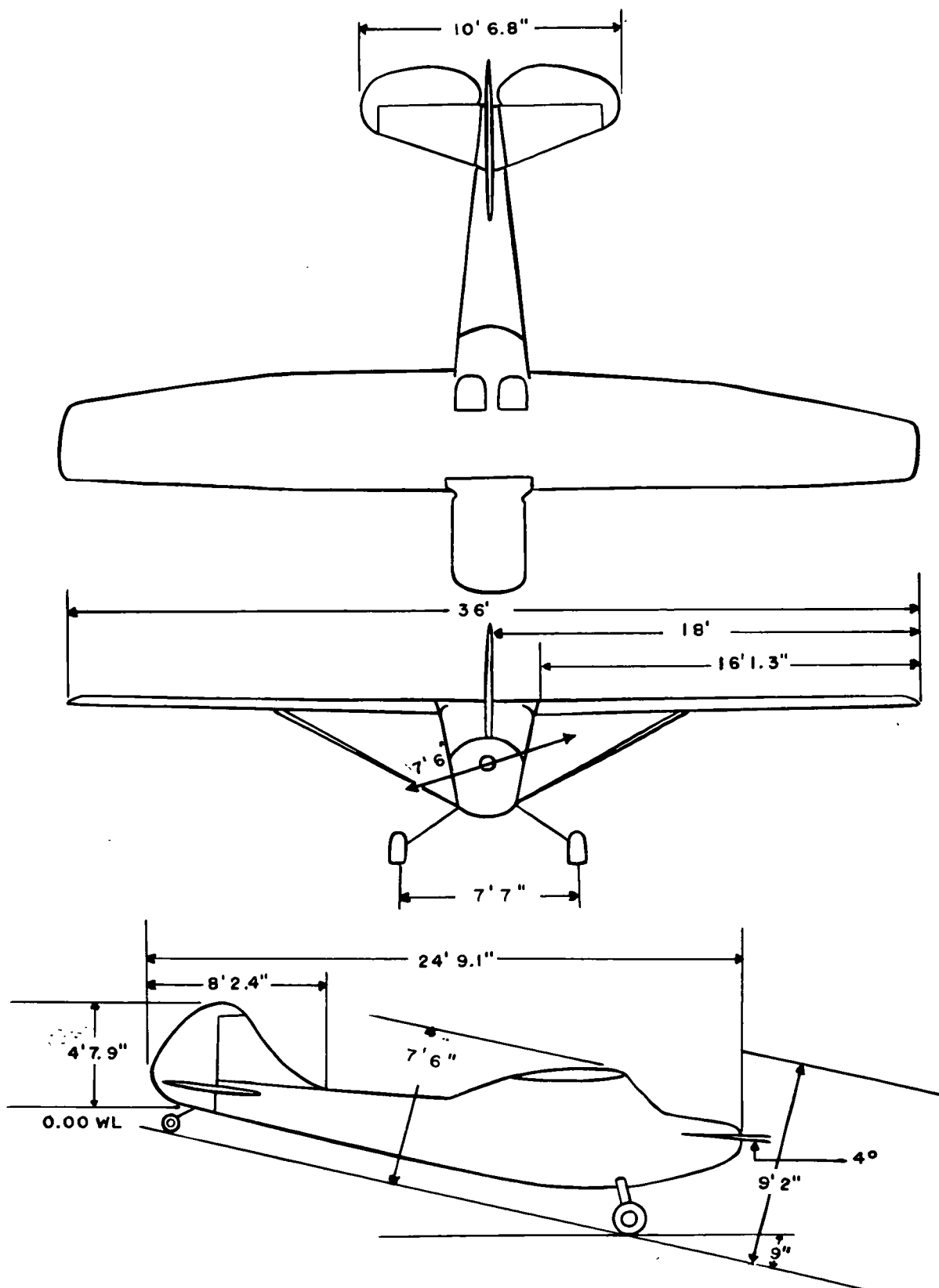


Figure 2-3. O-1E (Bird Dog).

WING
AREA 330 SQ. FT
MAC 98 IN.
ASPECT RATIO 5.35
SECTION
NACA 2412
SWEEP AT 40% CHORD 0

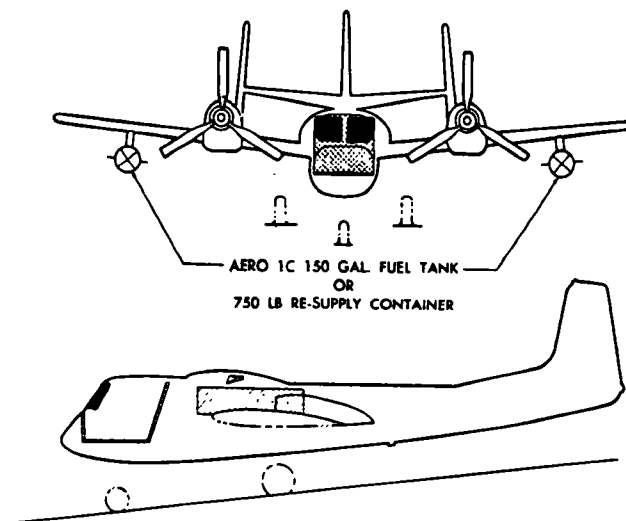
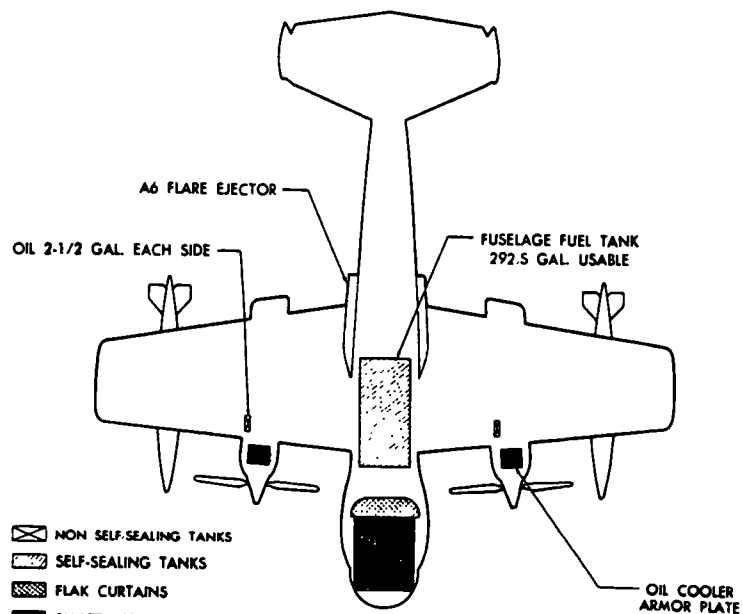
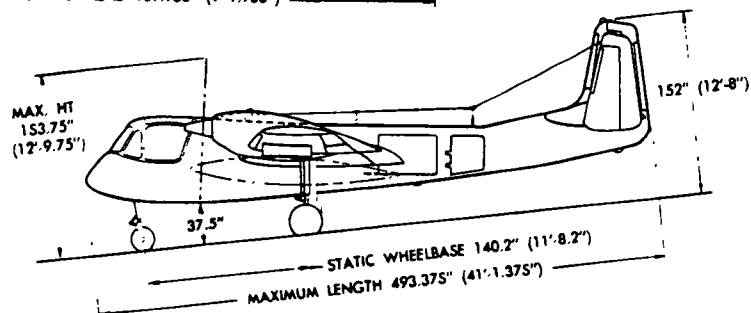
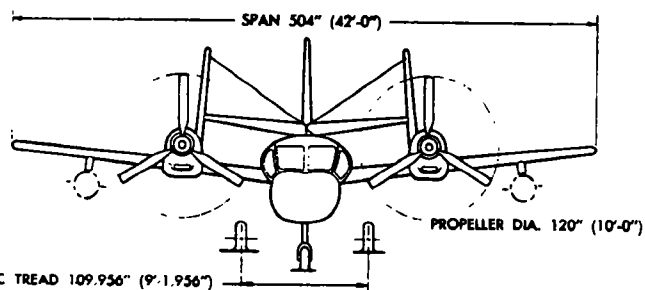
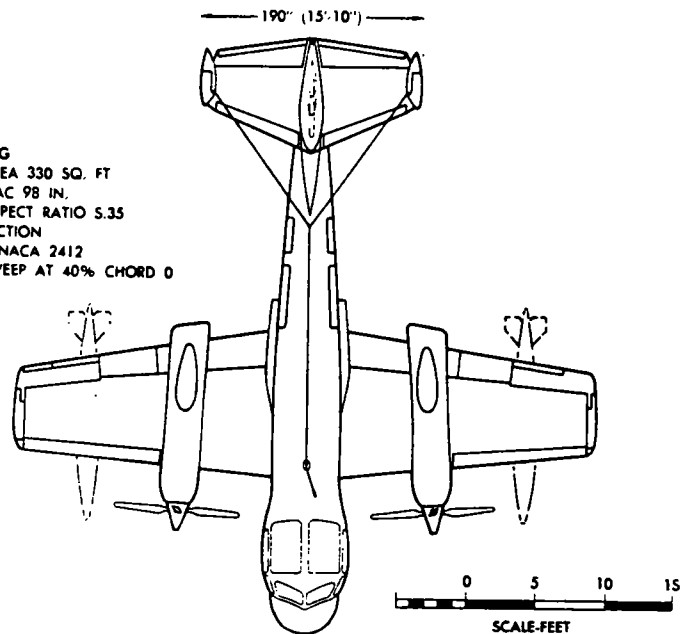


Figure 2-4. OV-1A (Mohawk).

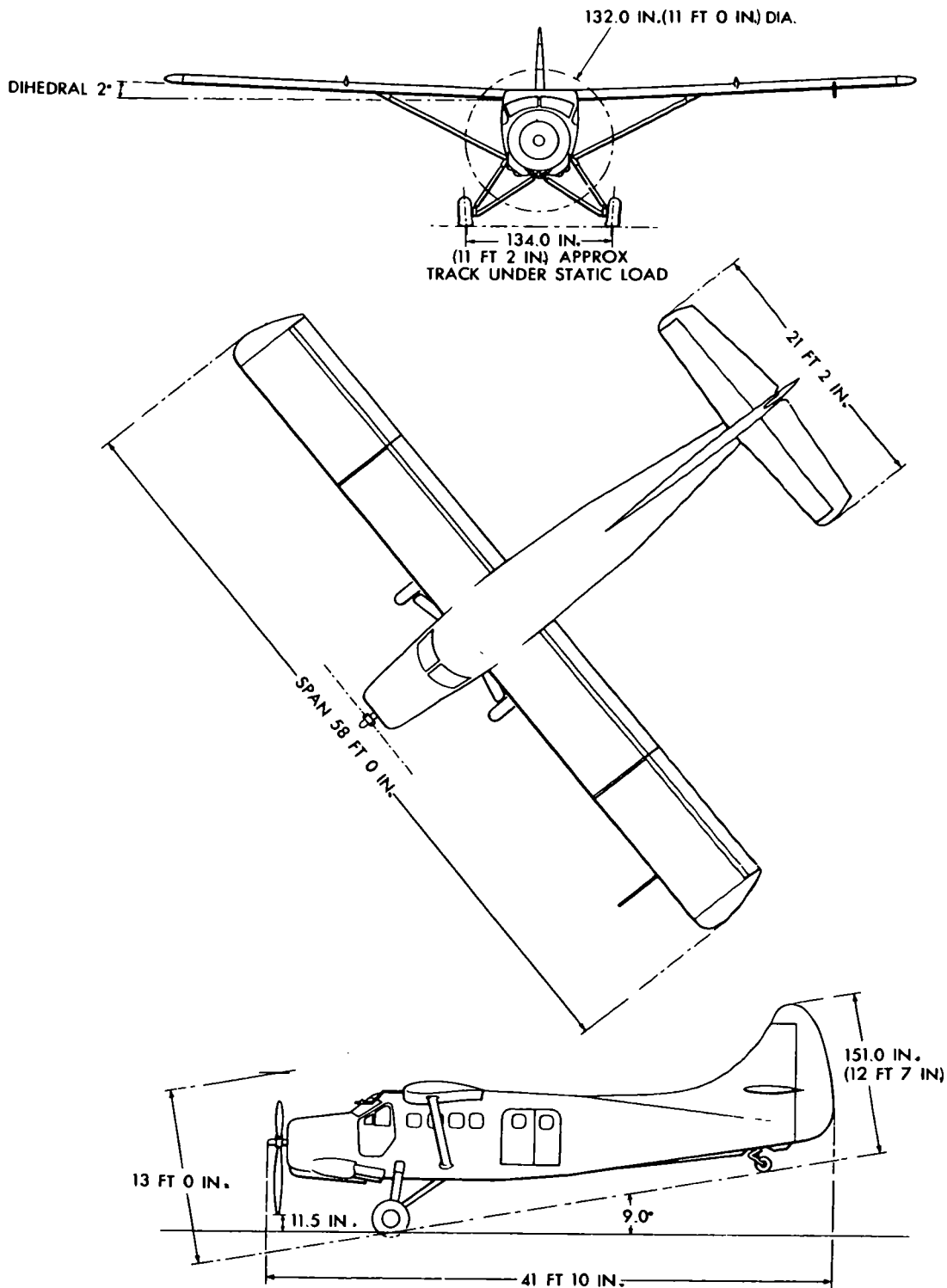


Figure 2-5. U-1A (Otter).

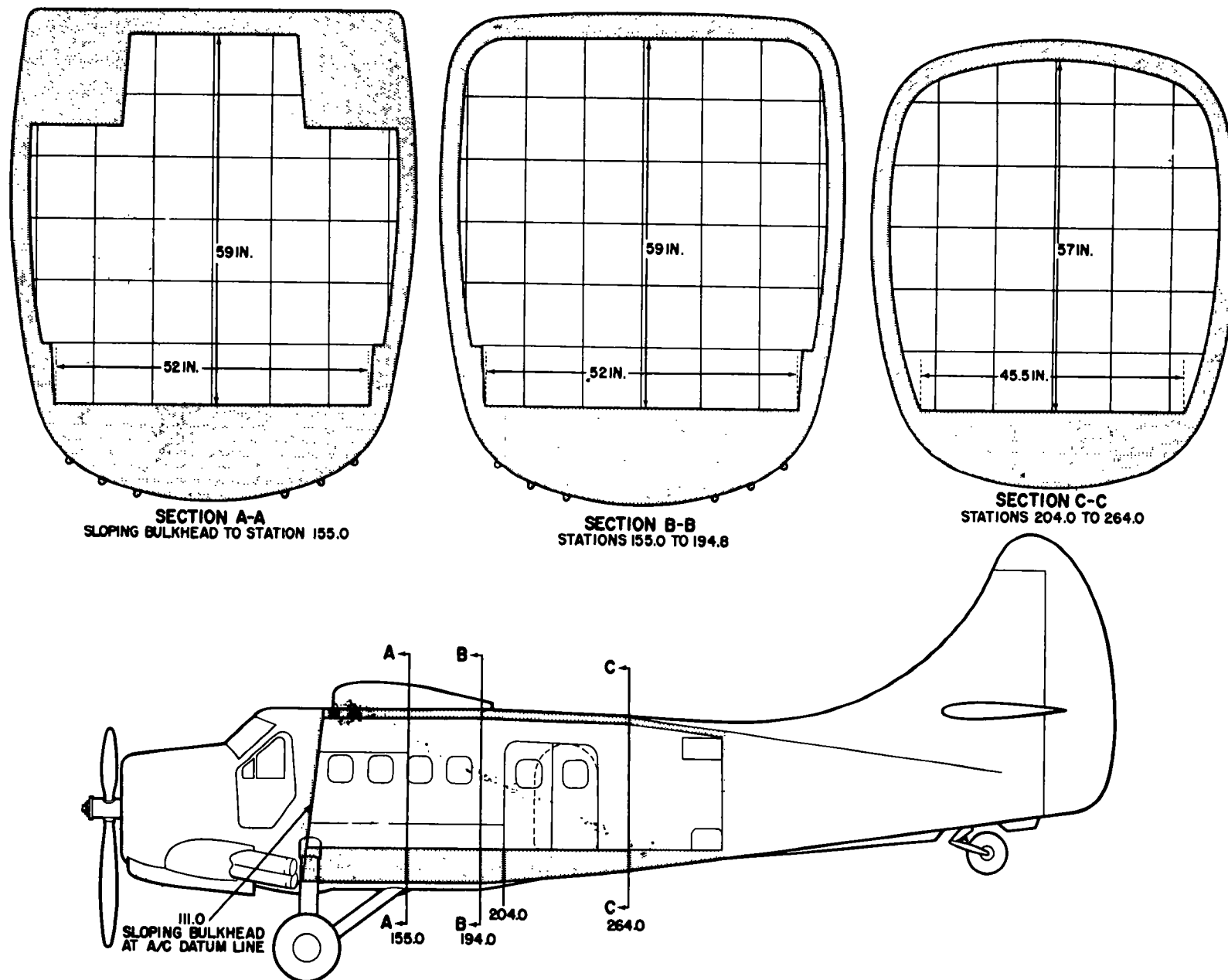
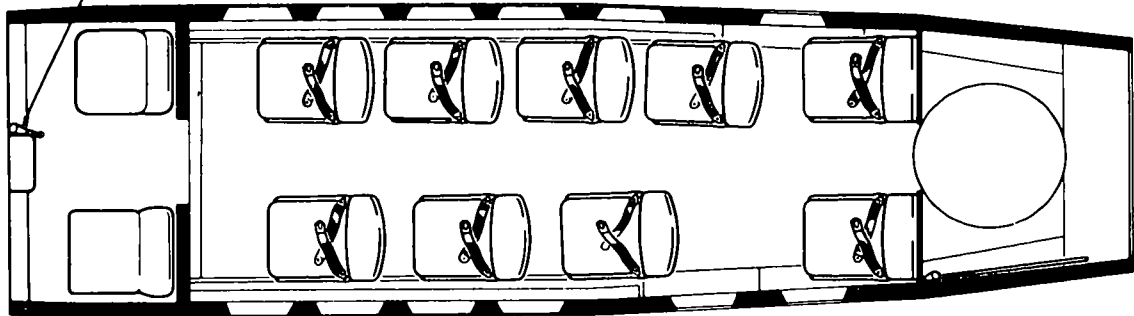


Figure 2-6. U-1A (Otter). Cabin dimensions.

COCKPIT RELIEF TUBE



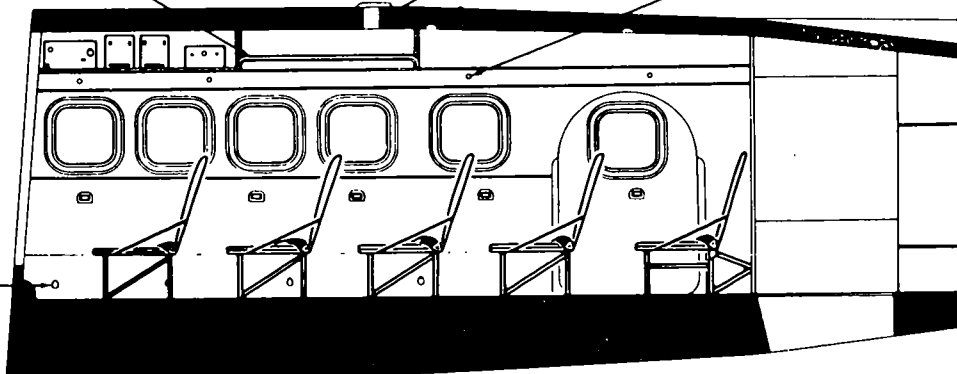
PLAN VIEW - COCKPIT AND CABIN

LUGGAGE RACK

EXHAUST VENTILATOR

VENTILATOR KNOB

HOT AIR OUTLET

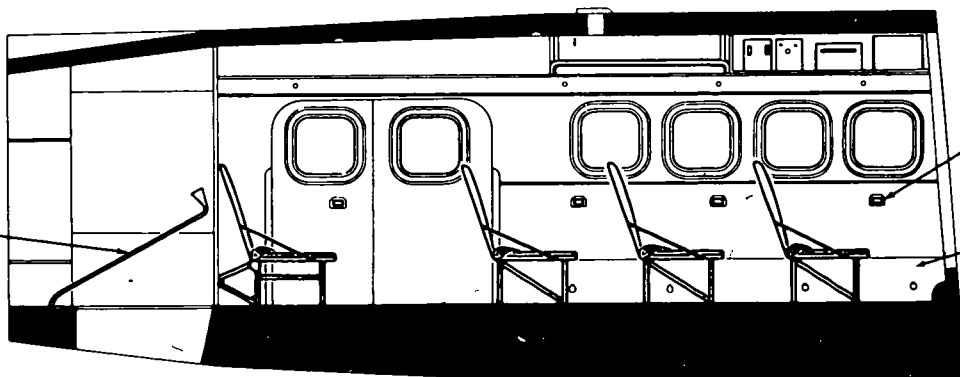


RIGHT-HAND SIDE VIEW - CABIN

CABIN RELIEF TUBE

ASH TRAY

HEATER DUCT



LEFT-HAND SIDE VIEW - CABIN

Figure 2-7. U-1A (Otter). Troop seating.

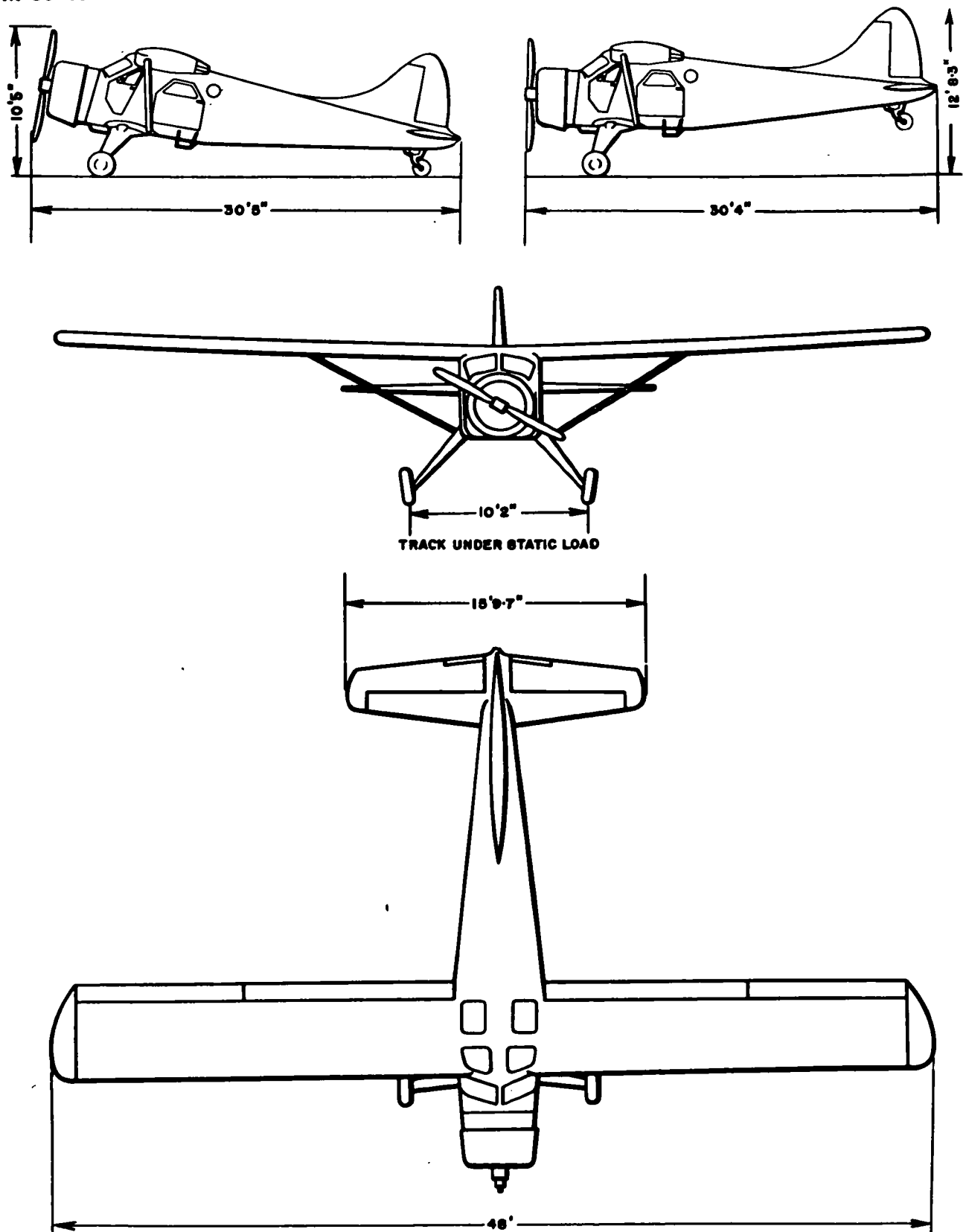


Figure 2-8. U-6A (Beaver).

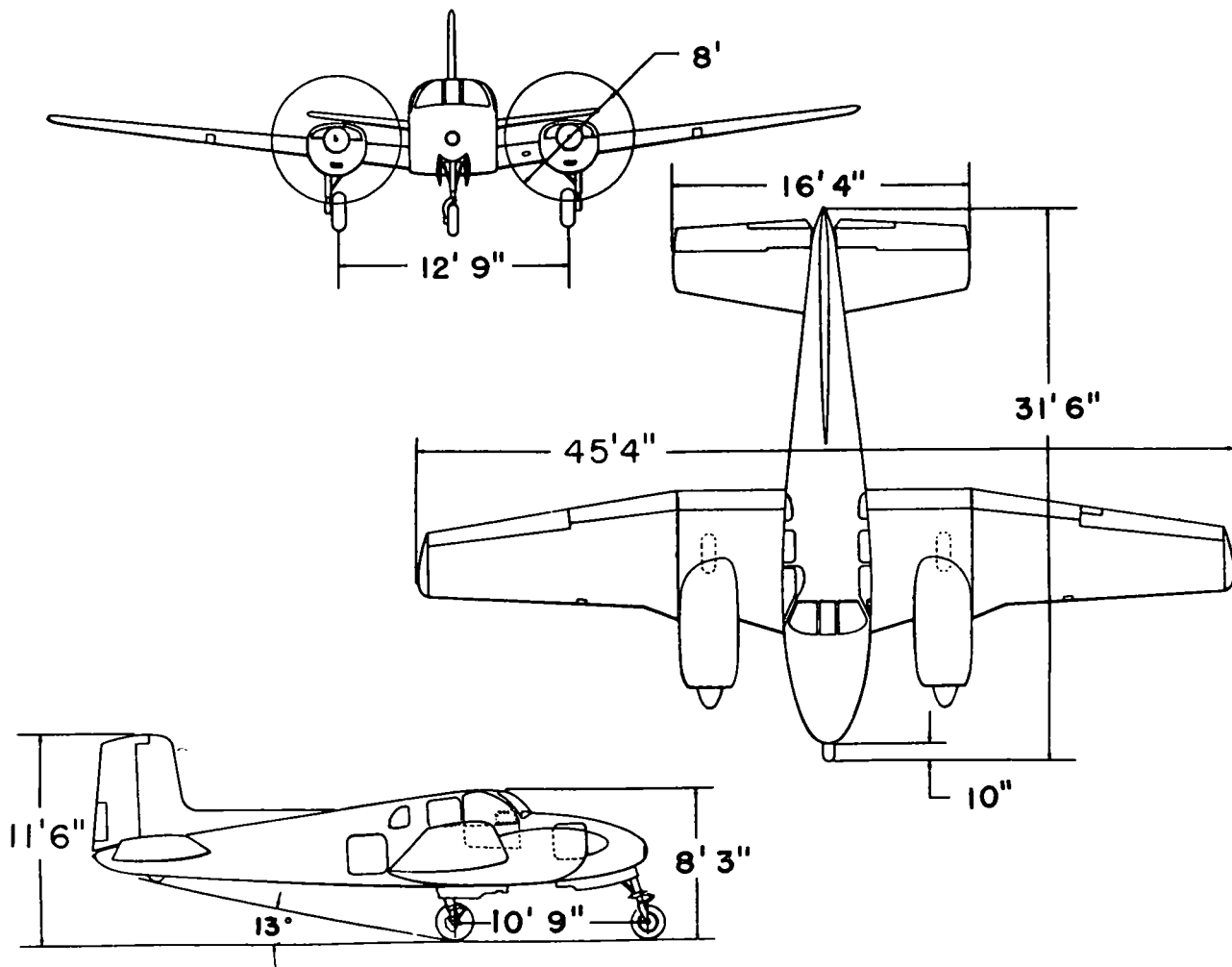


Figure 2-9. U-3D (Seminole).

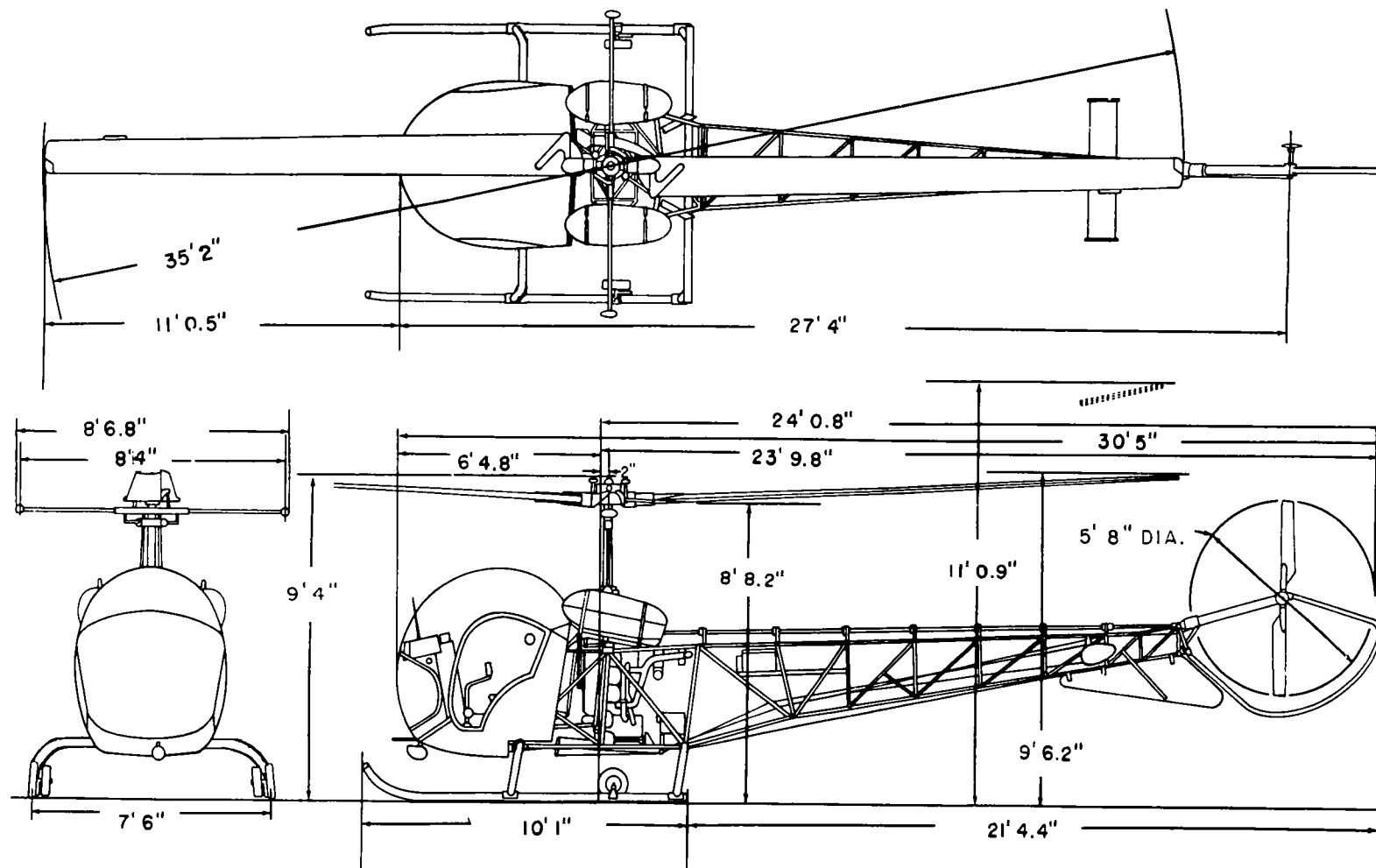


Figure 2-10. OH-13H (Sioux).

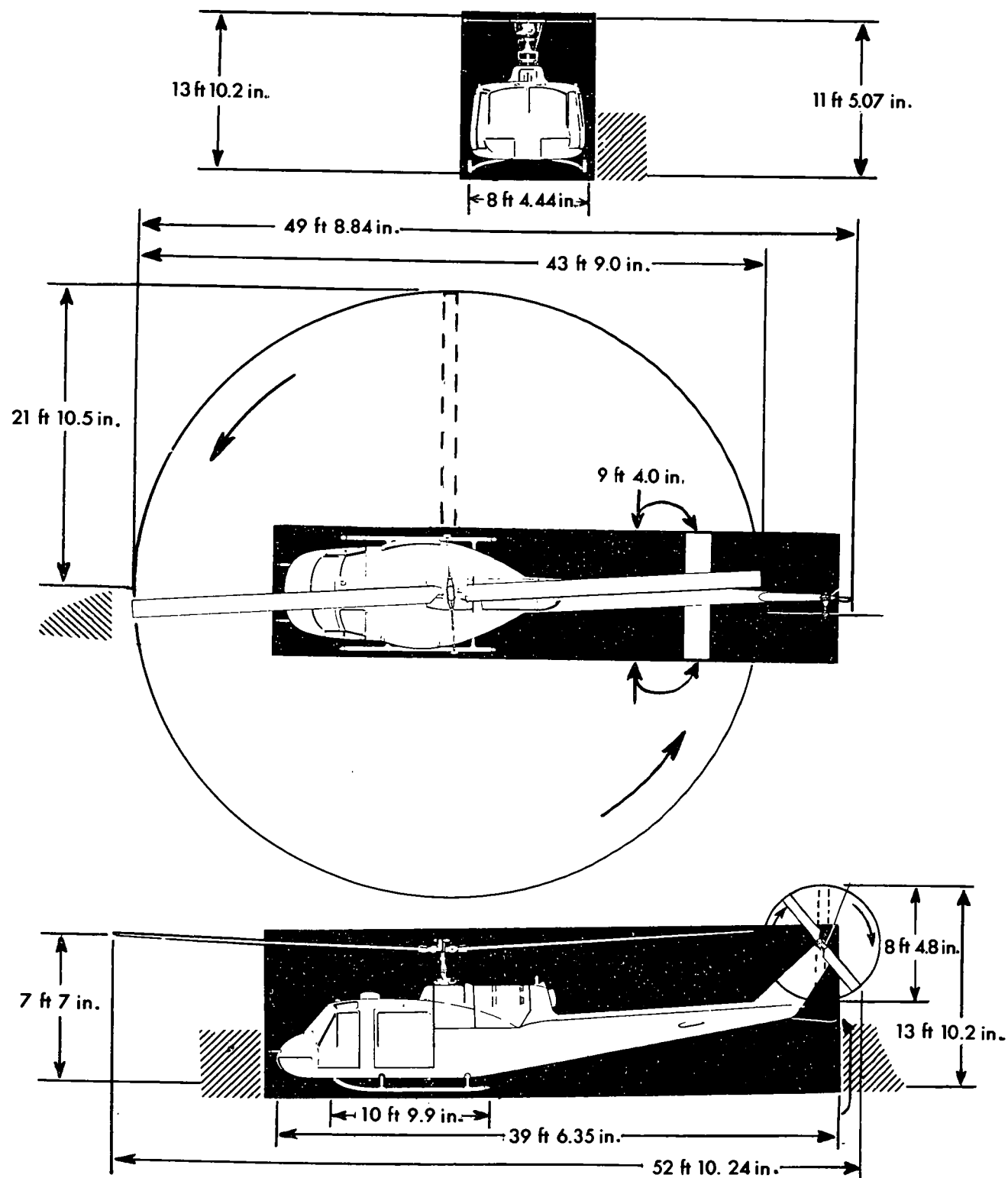


Figure 2-12. UH-1A (Iroquois).

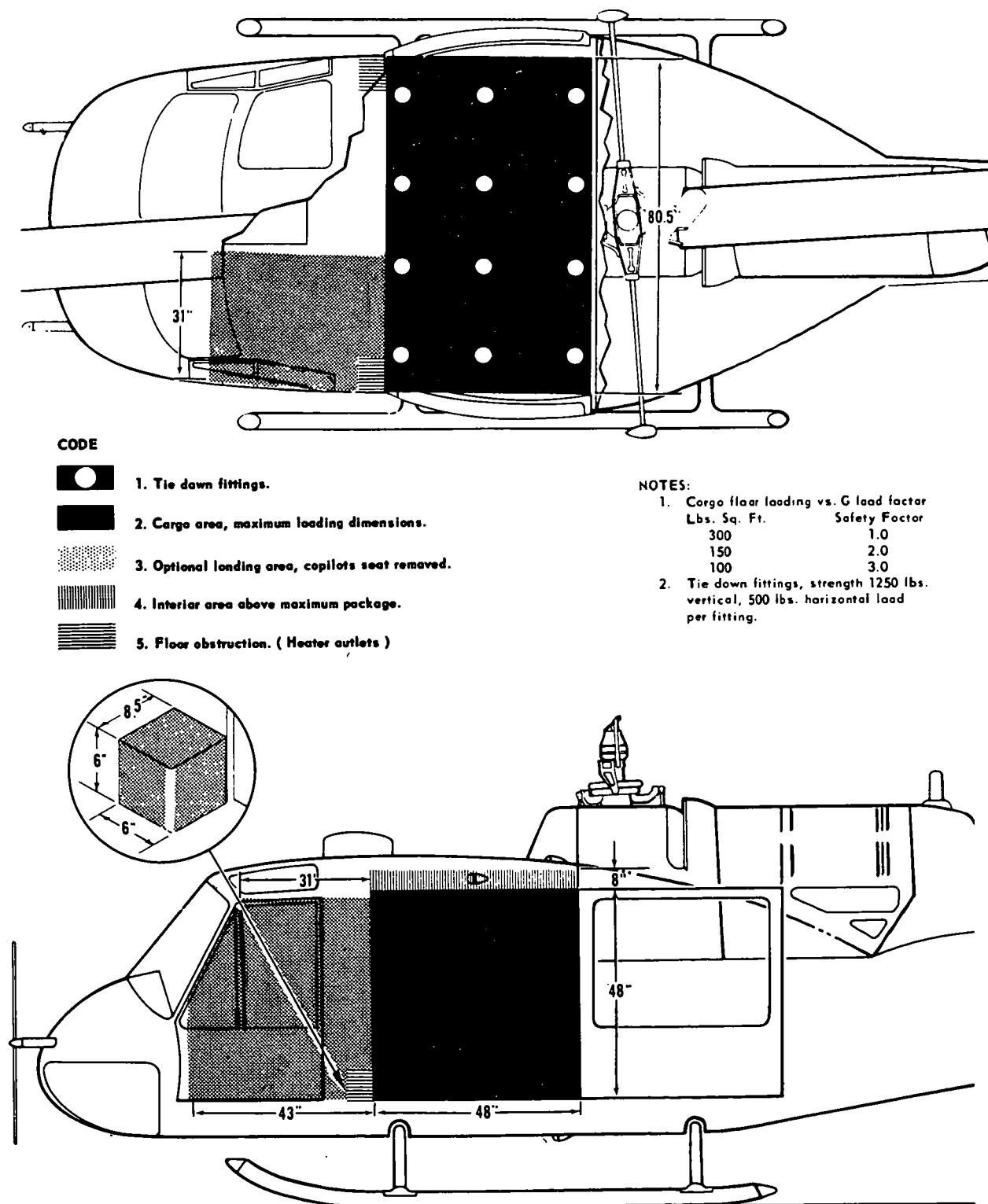


Figure 2-13. UH-1A (Iroquois). Cargo features.

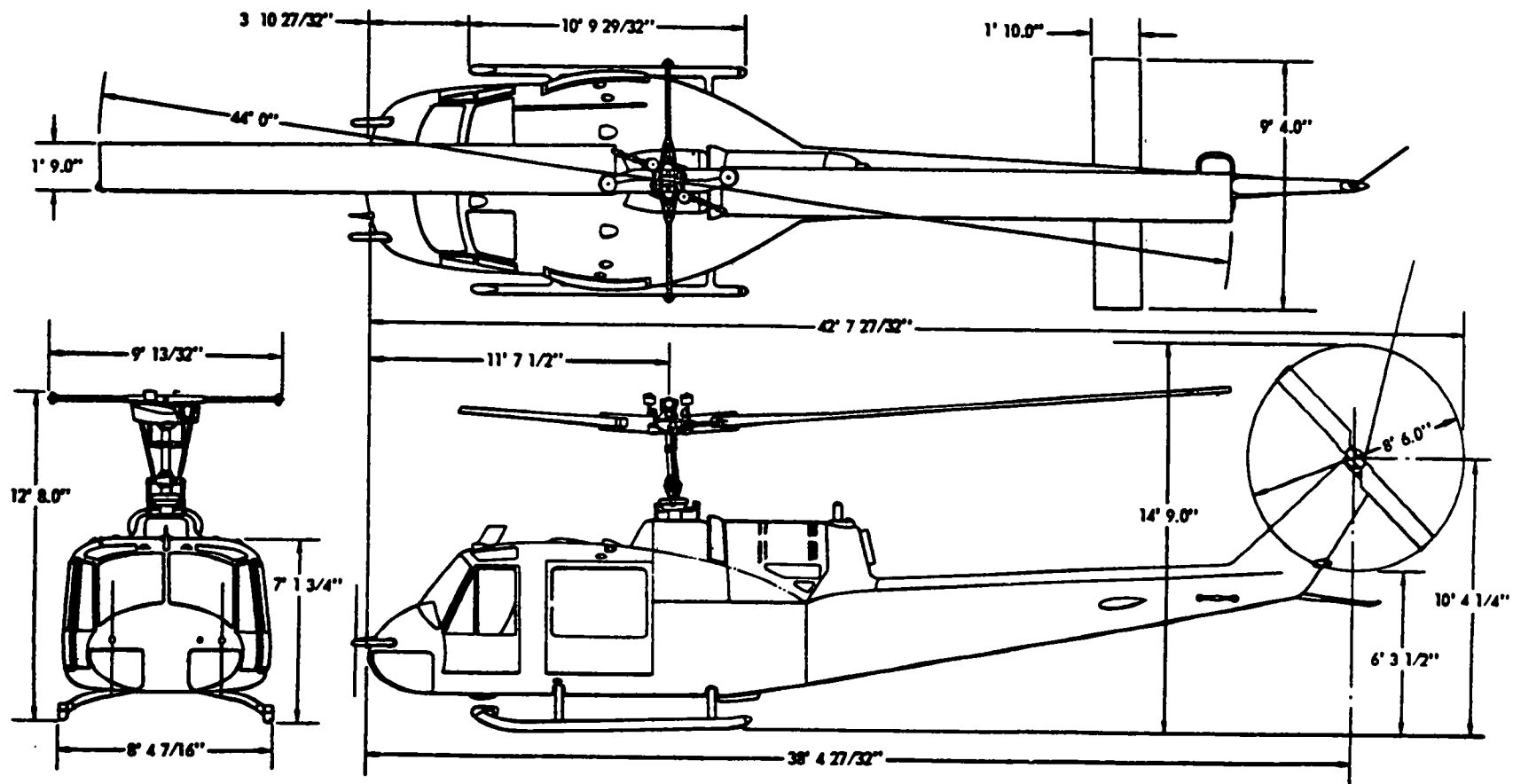
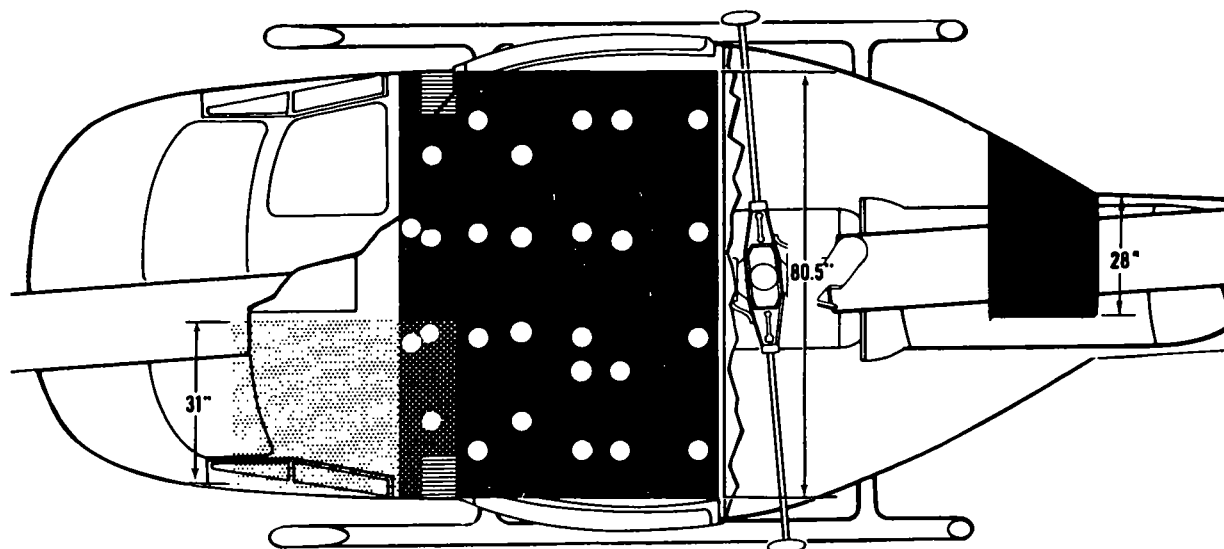


Figure 2-14. UH-1B (Iroquois).



CODE



1. Tie down fittings.



2. Cargo area, maximum loading dimensions.



3. Optional loading area, copilots seat removed.



4. Interior area above maximum package.



5. Floor obstruction. (Heater outlets)

NOTES:

- Cargo floor loading vs. G load factor

Lbs. Sq. Ft.	Safety Factor
300	1.0
150	2.0
100	3.0
- Tie down fittings, strength 1250 lbs. vertical, 500 lbs. horizontal load per fitting.

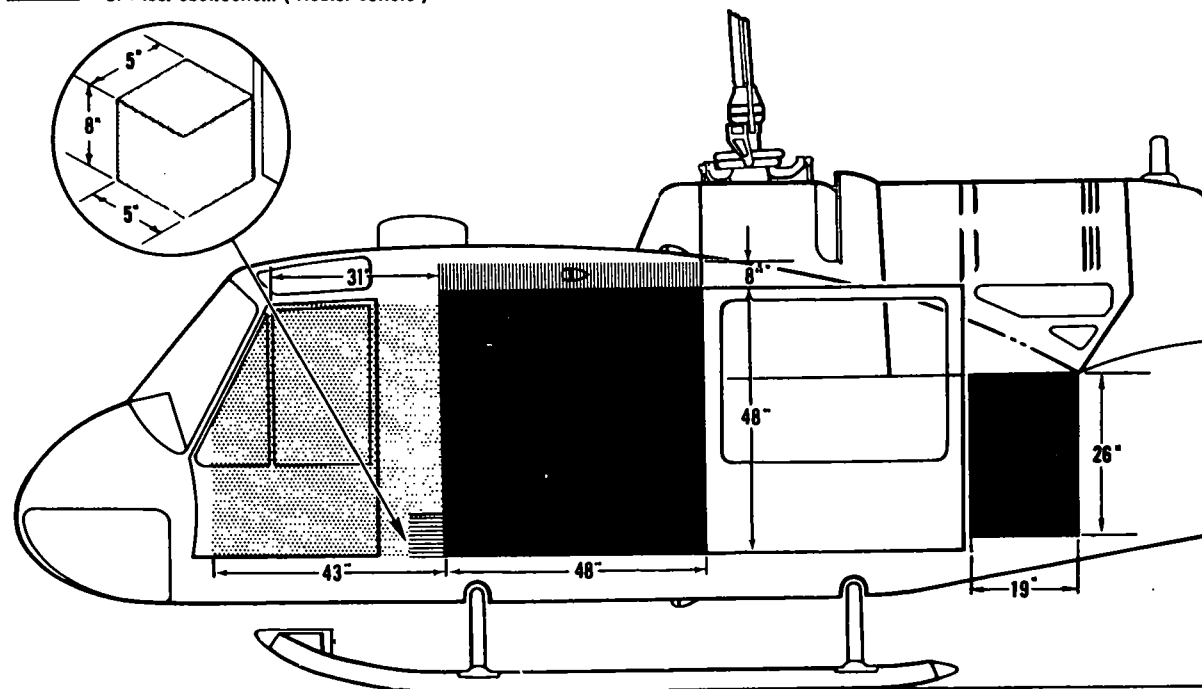


Figure 2-15. UH-1B (Iroquois). Cargo features.

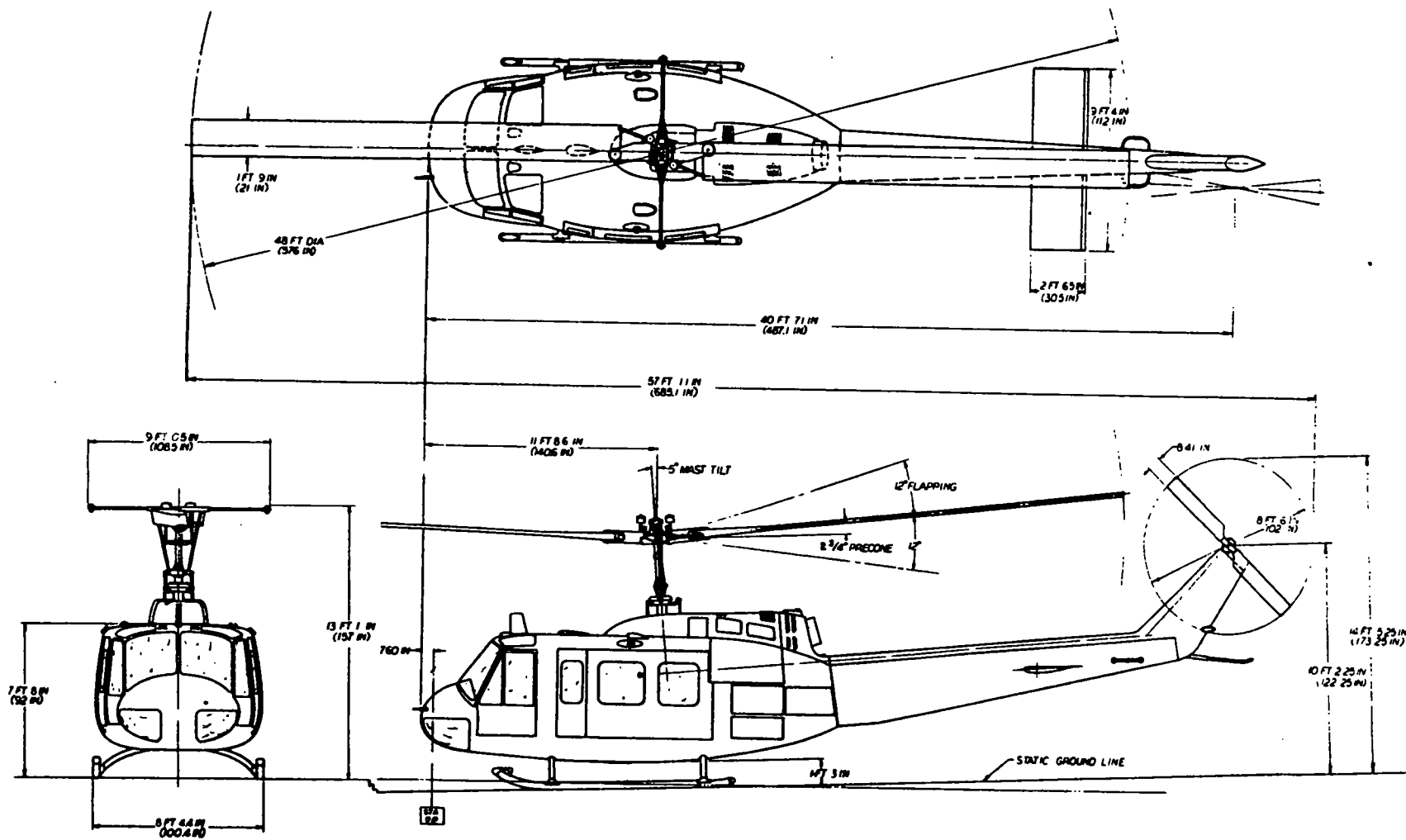
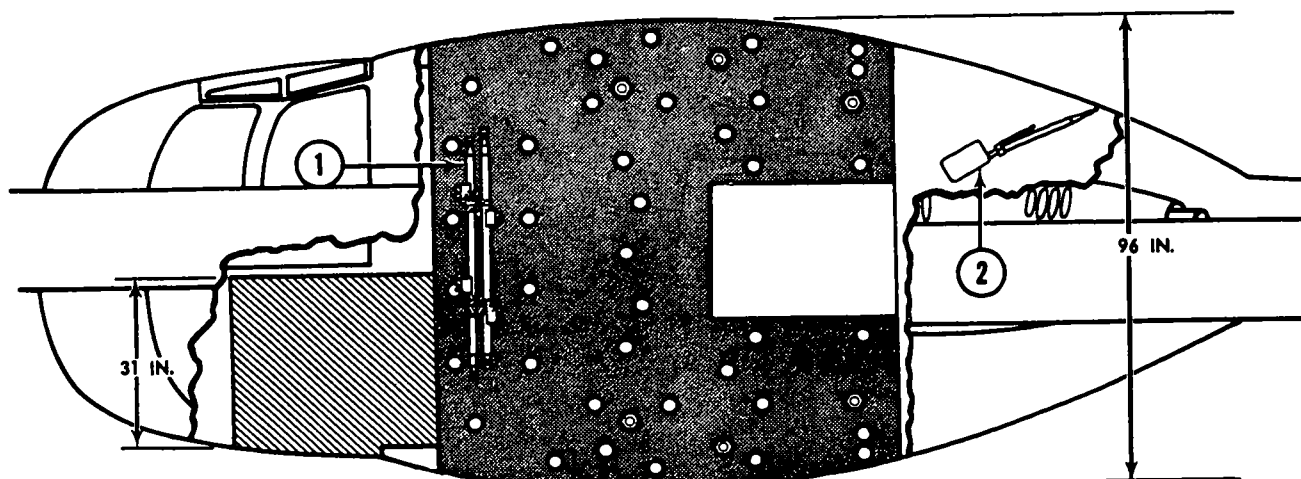


Figure 2-16. UH-1D. (Iroquois).



CODE

1. Tie-down fittings.
 2. Stanchion Fittings.
 3. Cargo area, maximum loading dimensions.
 4. Optional loading area, copilot's seat removed.
 5. Interior clearance above maximum package at Q_c of cabin.
- ① Stanchion Stowage
 ② Mirror Stowage

NOTES:

1. Cargo floor loading vs. G load factor
- | Lb | Sq Ft | Safety Factor |
|-----|-------|---------------|
| 300 | | 1.0 |
| 150 | | 2.0 |
| 100 | | 3.0 |
2. Tie-down fittings, strength 1250 lb vertical, 500 lb horizontal load per fitting.

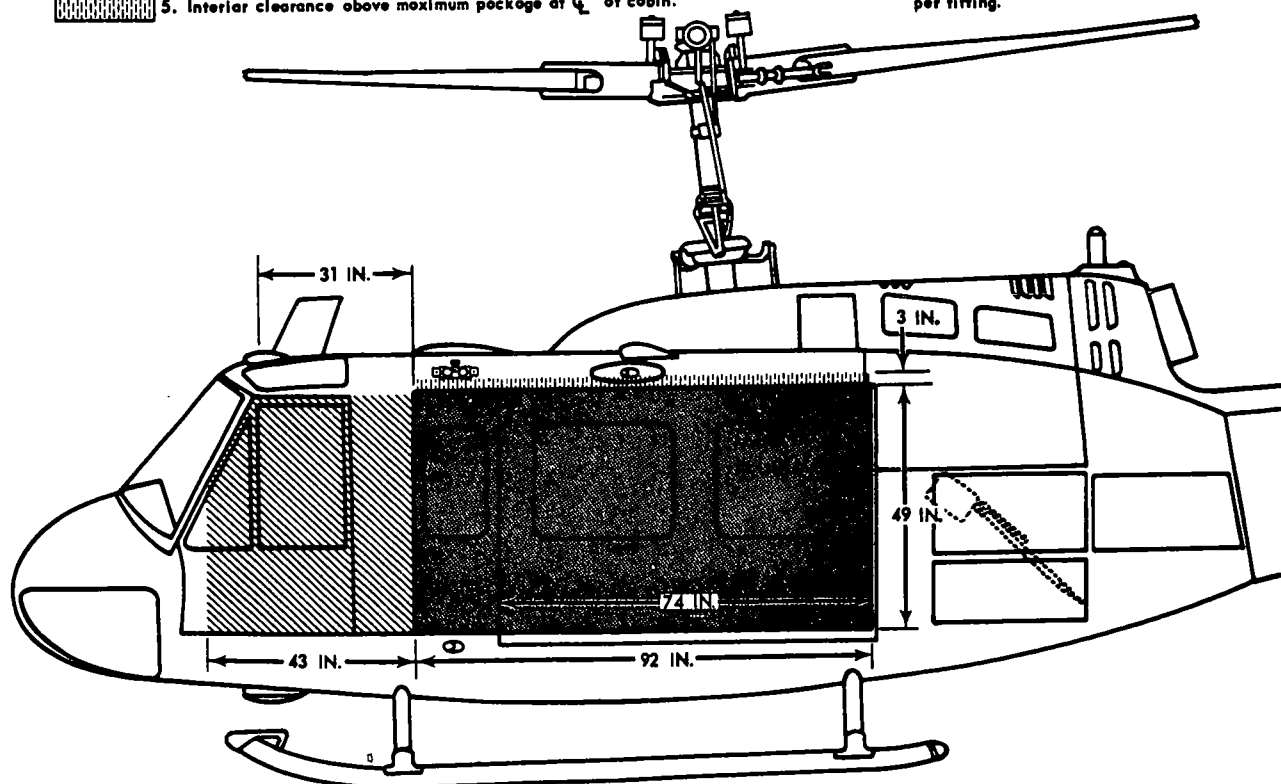


Figure 2-17. UH-1D. (Iroquois). Cargo features.

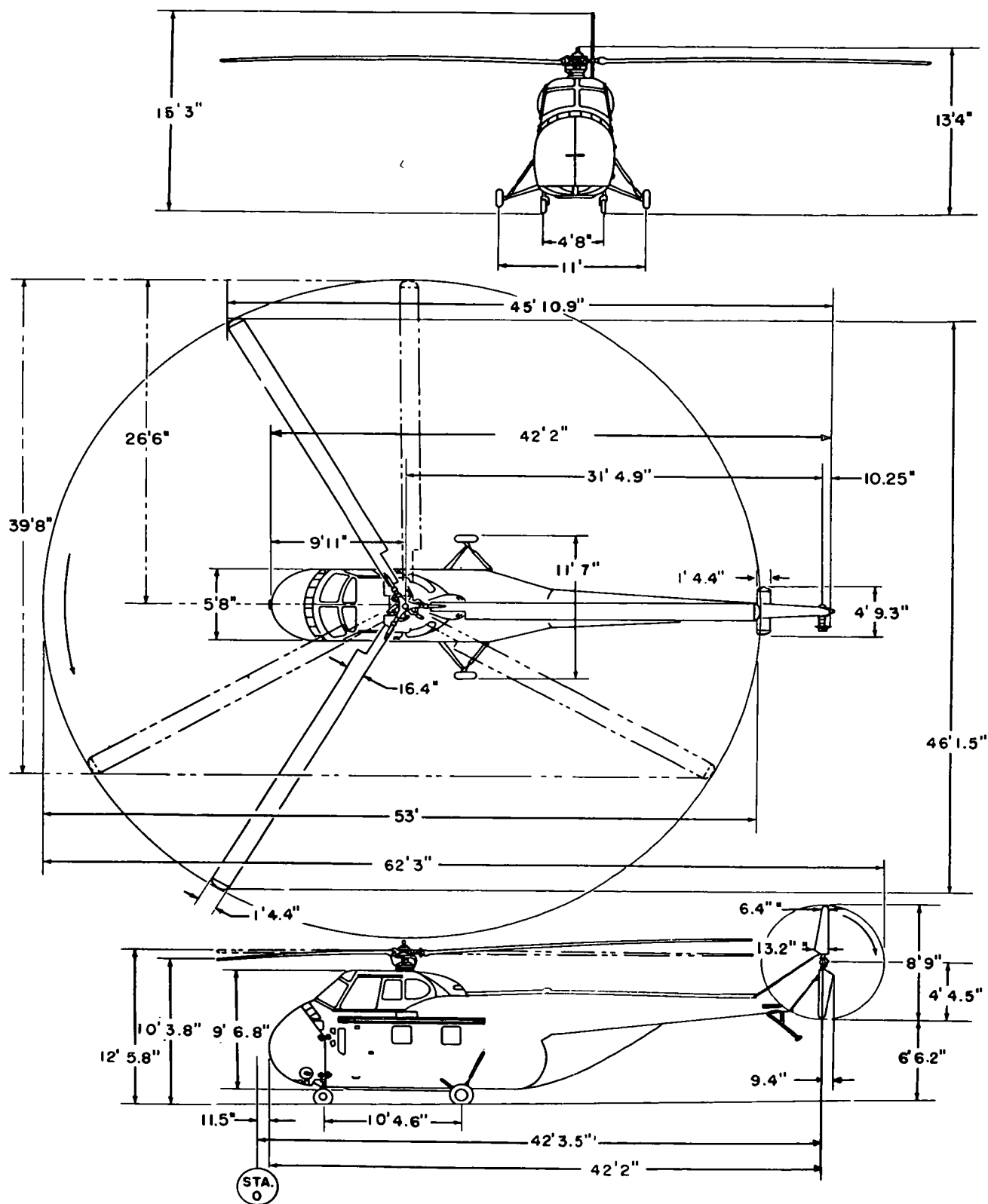


Figure 2-18. UH-19D (Chickasaw).

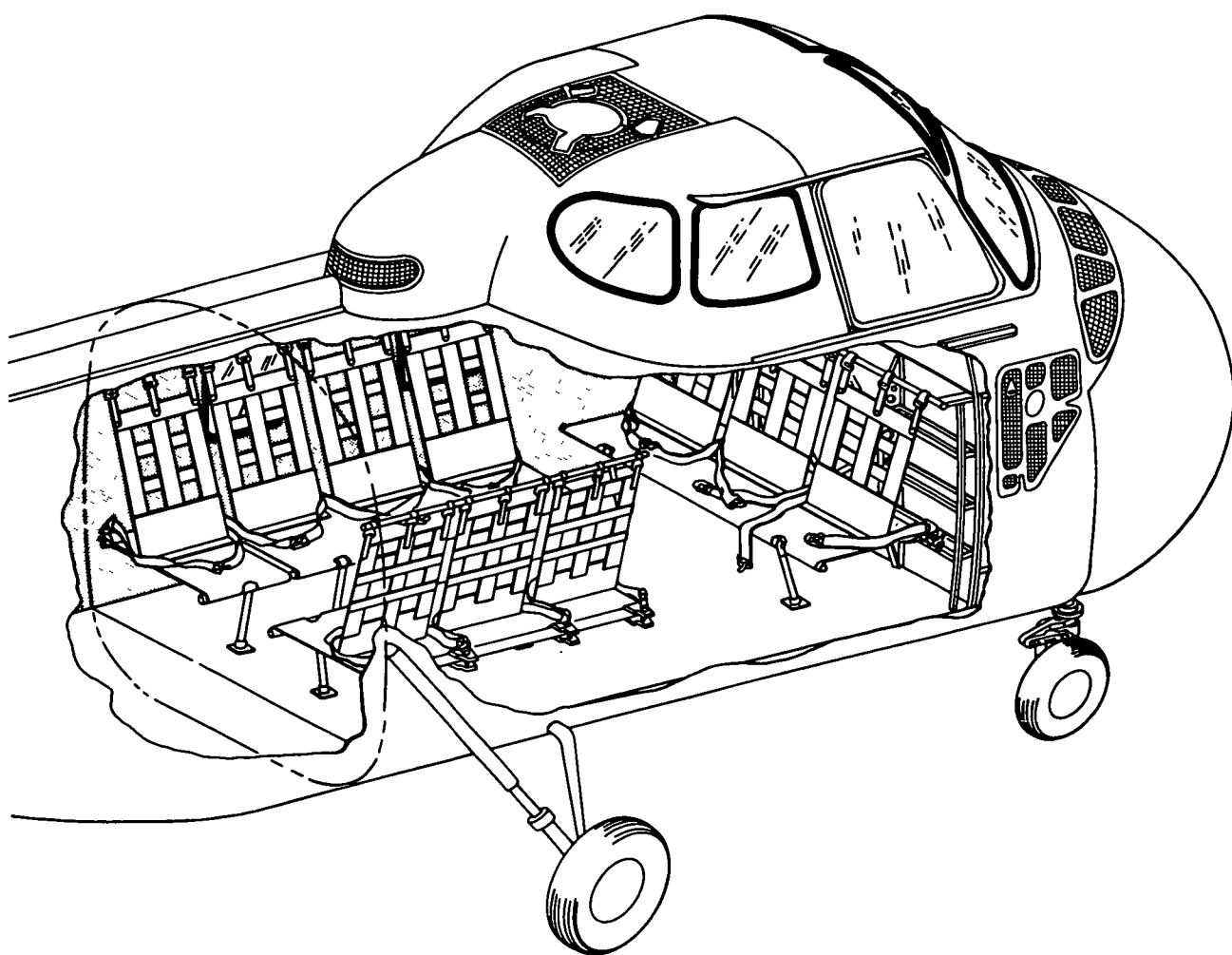


Figure 2-19. UH-19D (Chickasaw). Cabin.

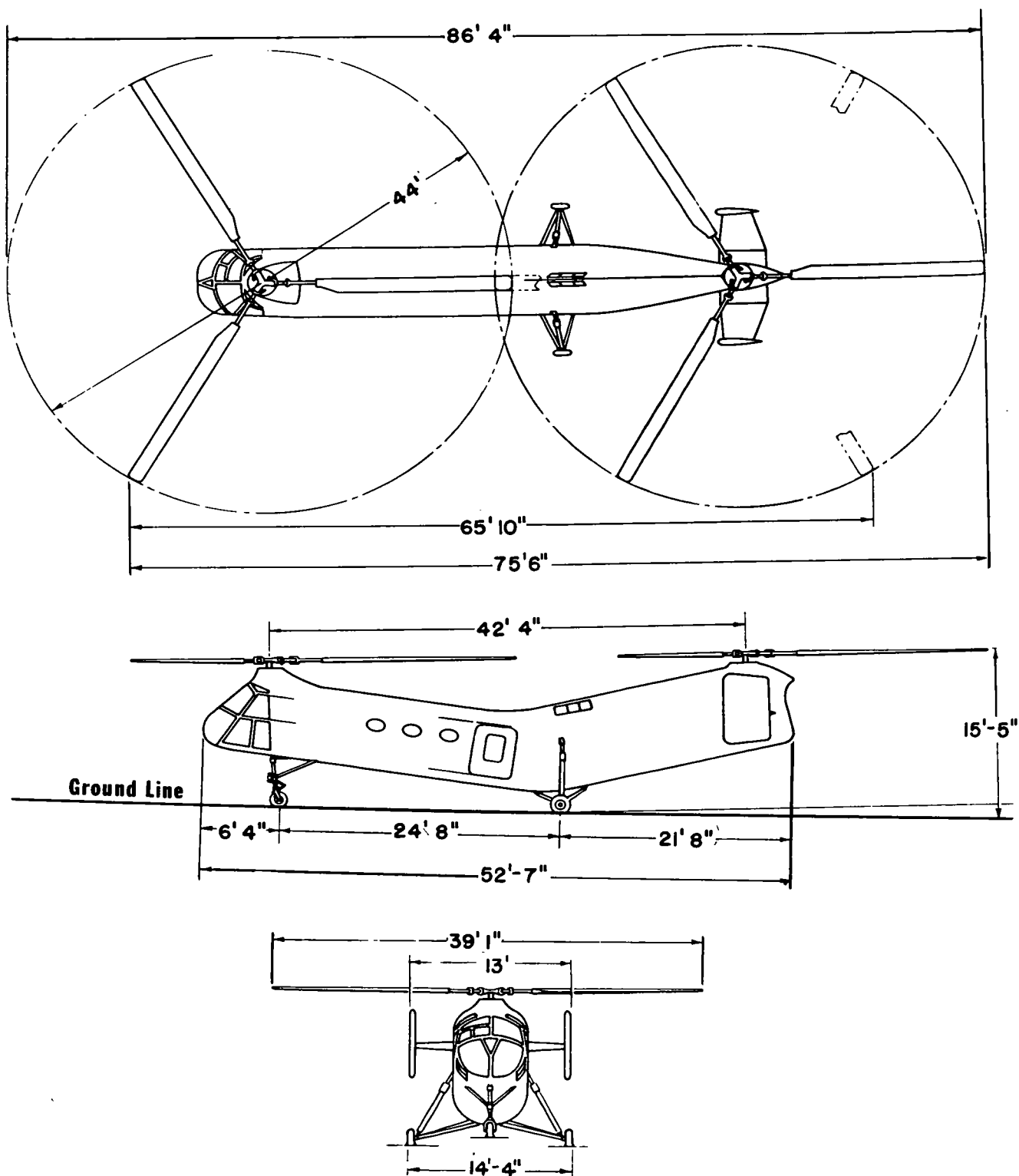


Figure 2-20. CH-21C (Shawnee).

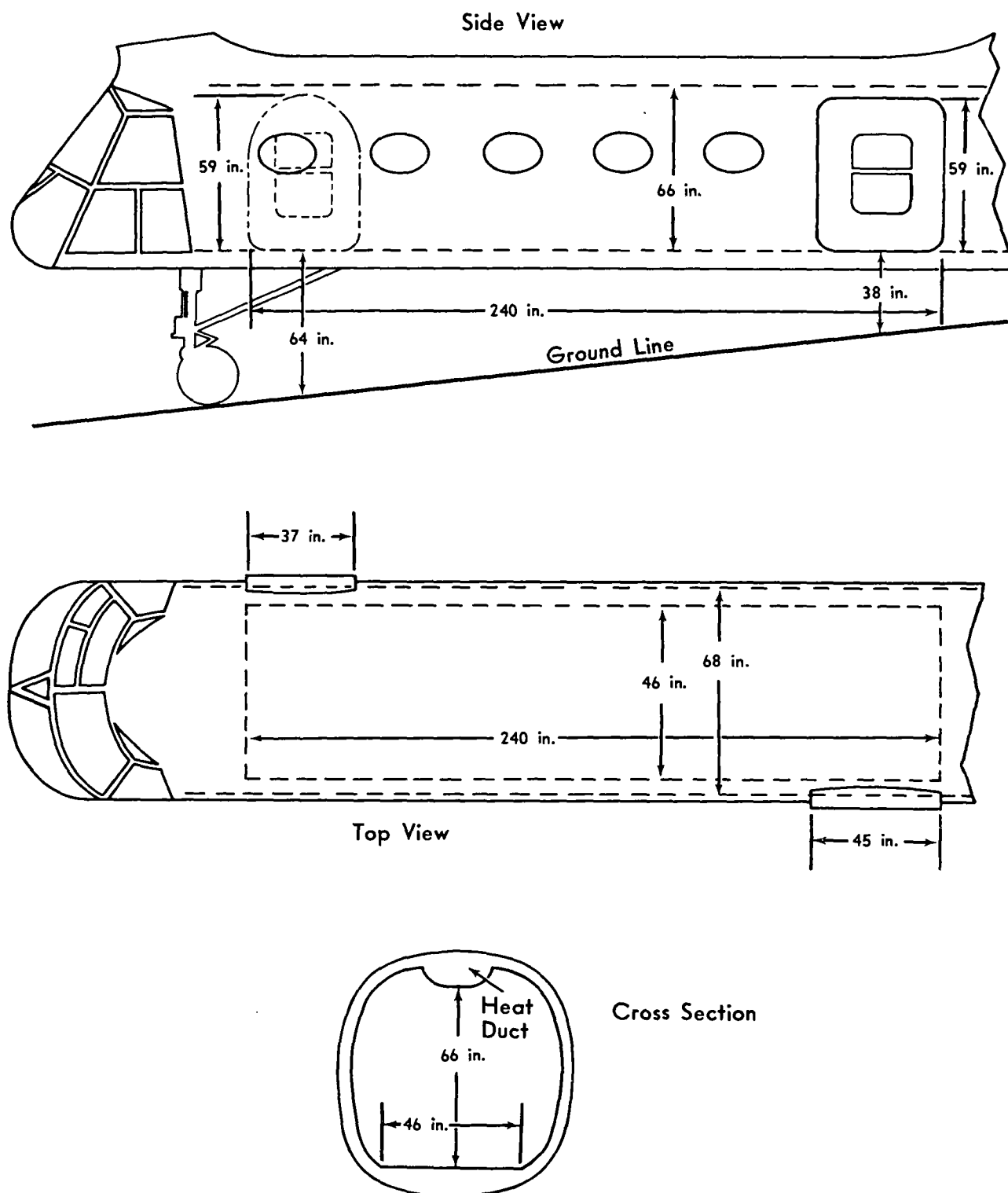


Figure 2-21. CH-21C (Shawnee). Cargo-passenger compartment dimensions.

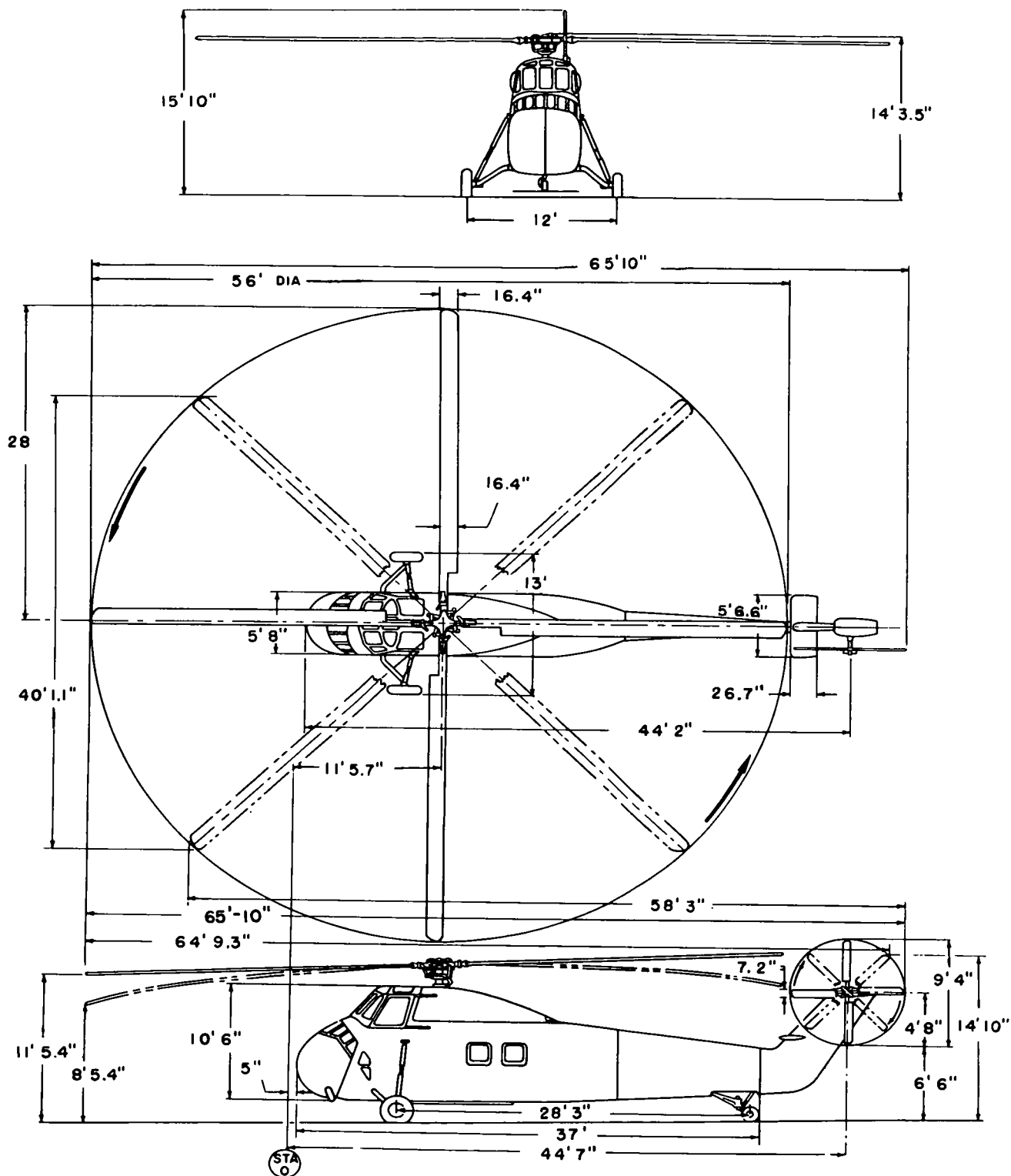


Figure 2-22. CH-84C (Choctaw).

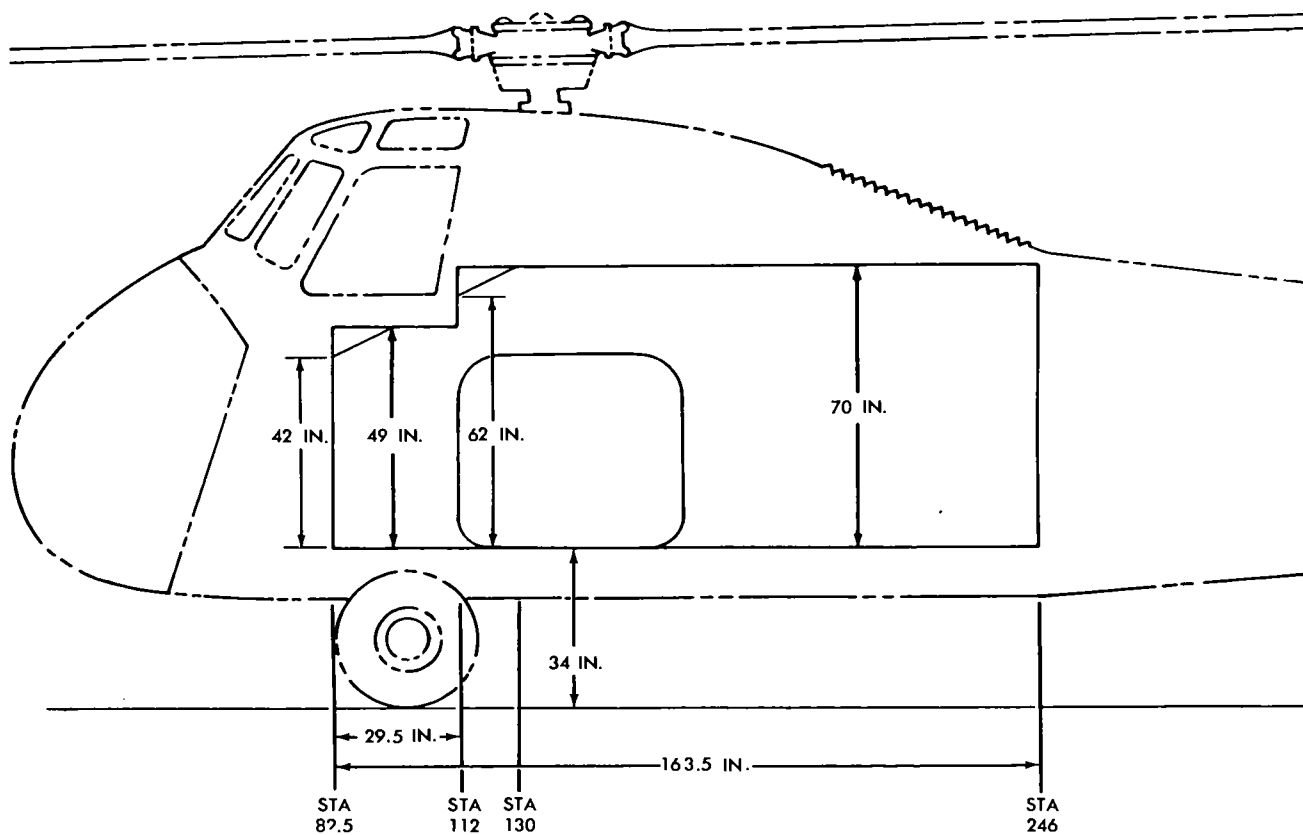
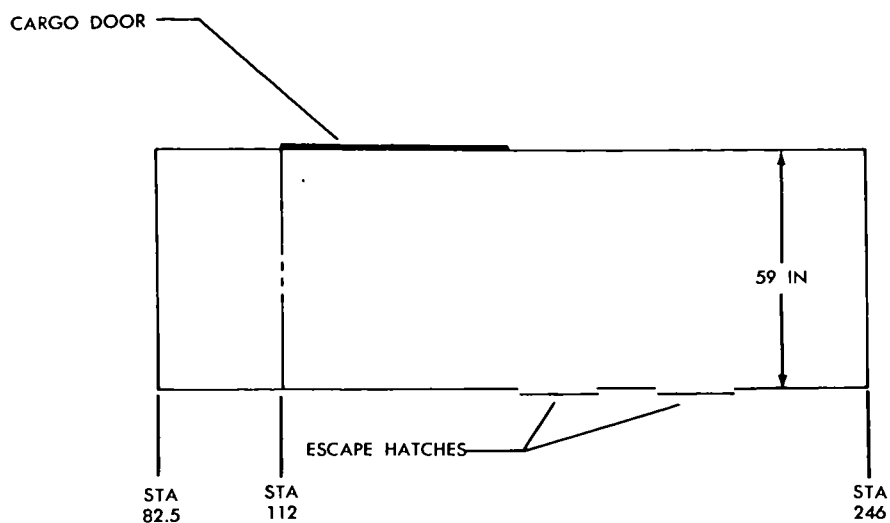


Figure 2-23. CH-34C (Choctaw). Cargo compartment dimensions.

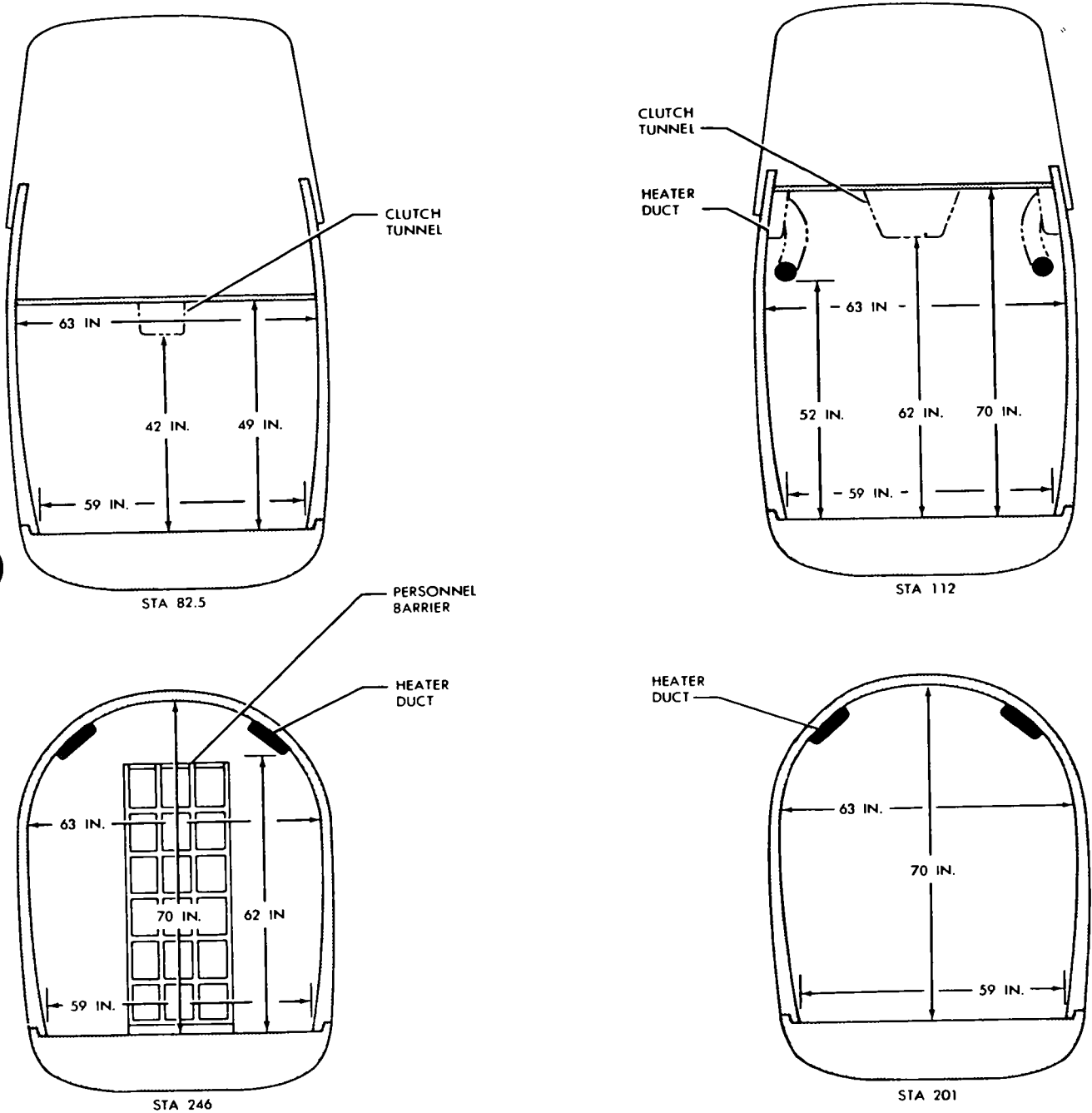


Figure 2-25. CH-37B (Mojave). Cargo compartment dimensions.

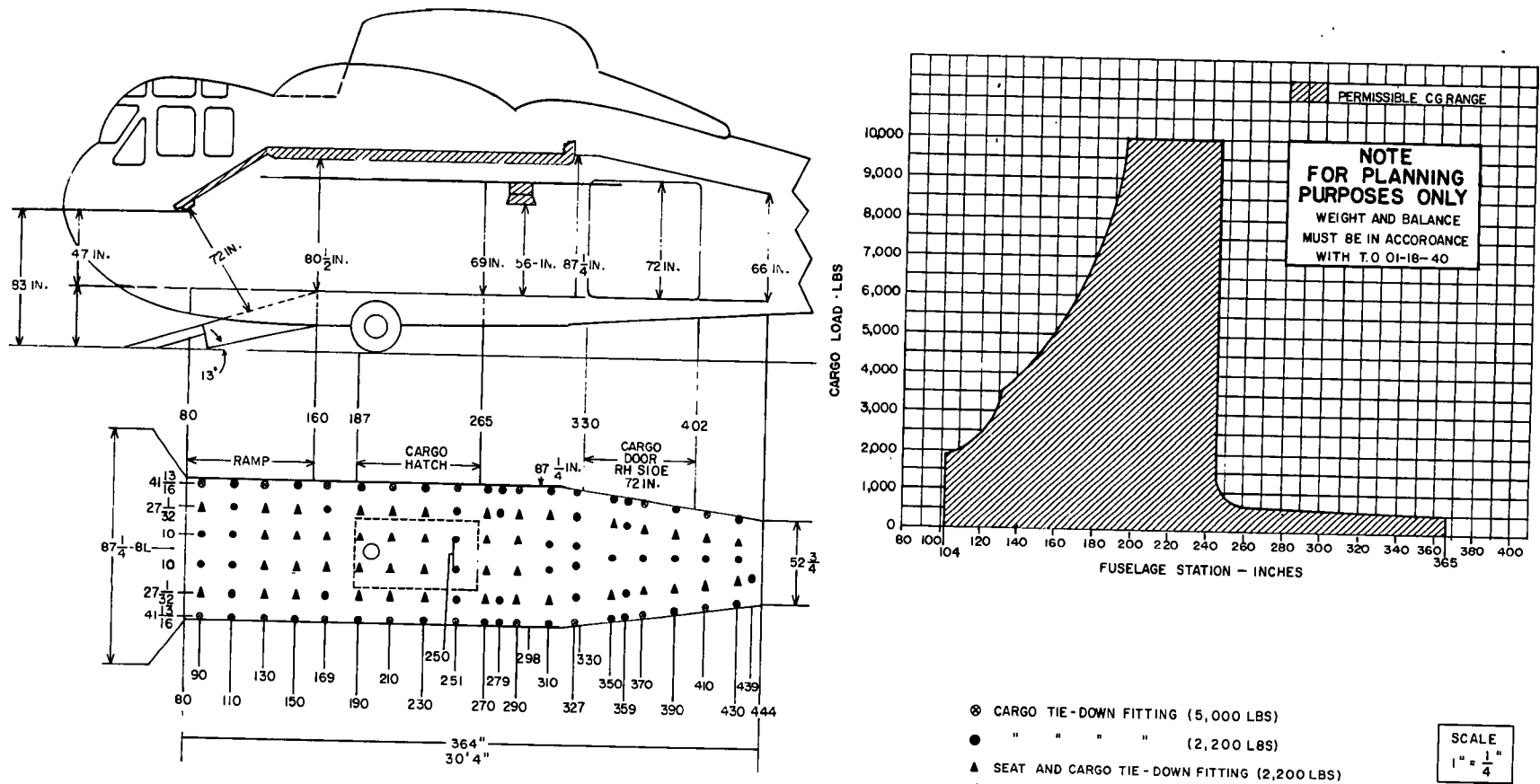


Figure 2-26. CH-37B (Mojave). Equipment load planner.

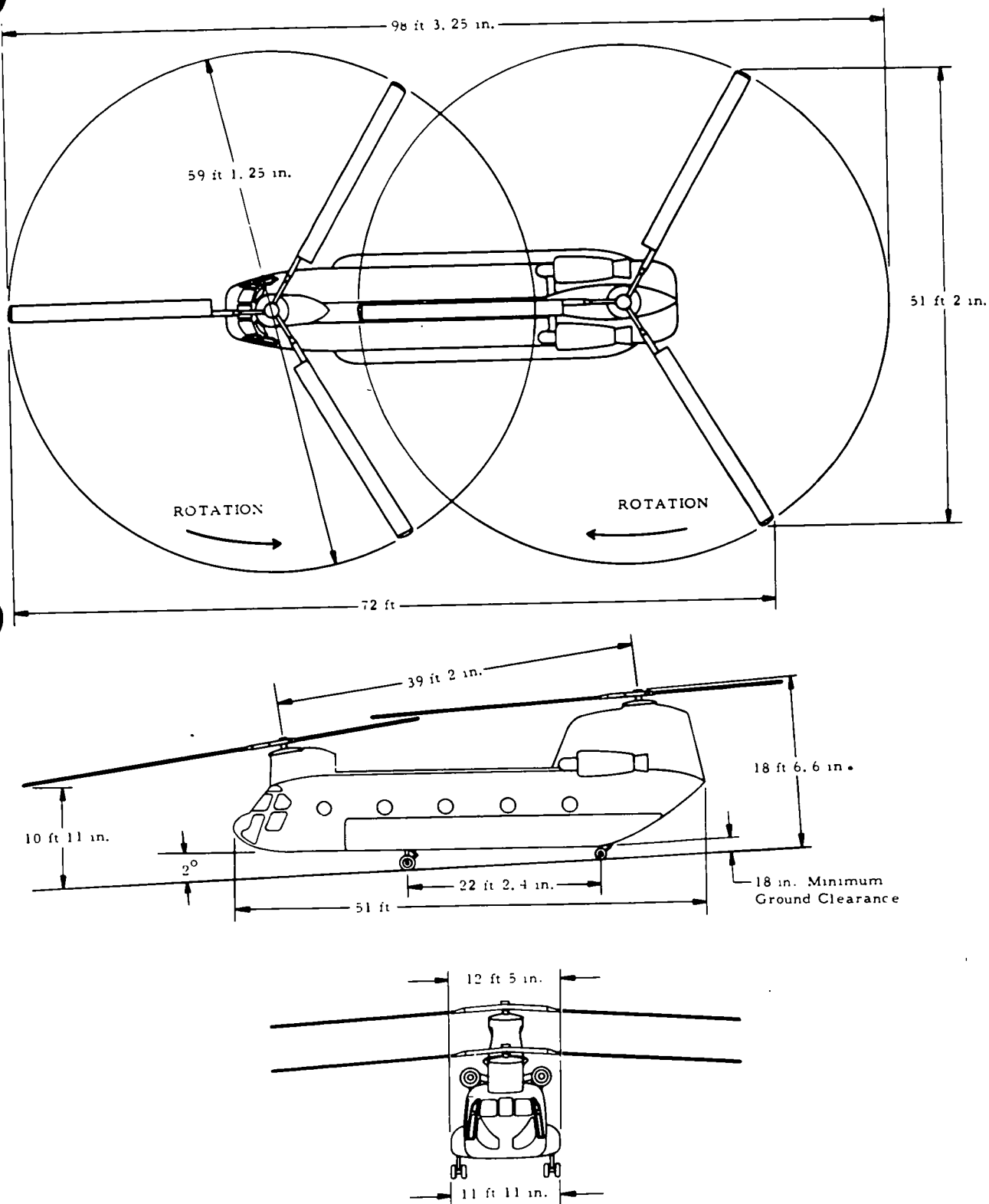


Figure 2-27. CH-47A (Chinook).

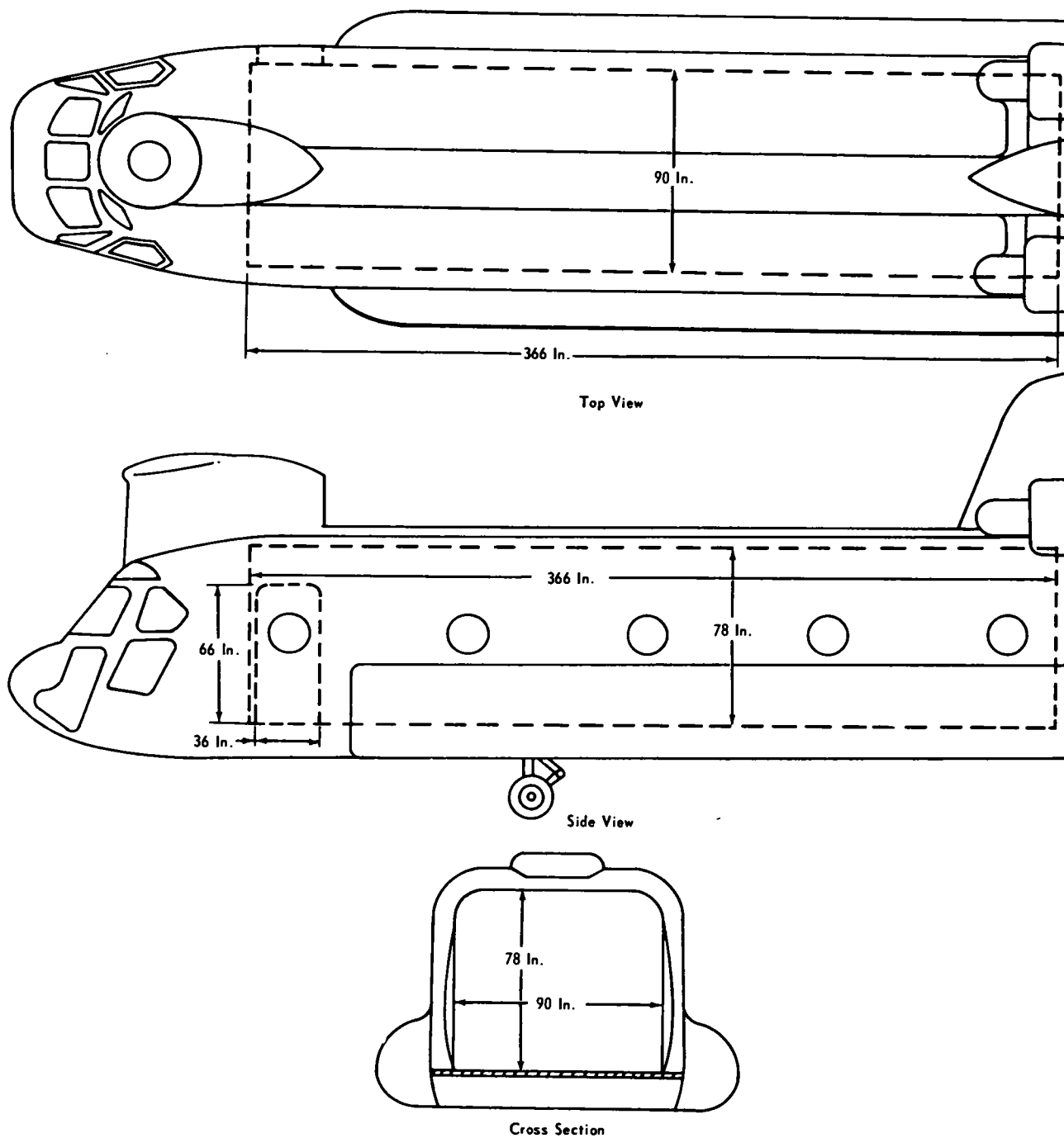


Figure 2-2^c CH-47A (Chinook). Cargo compartment.

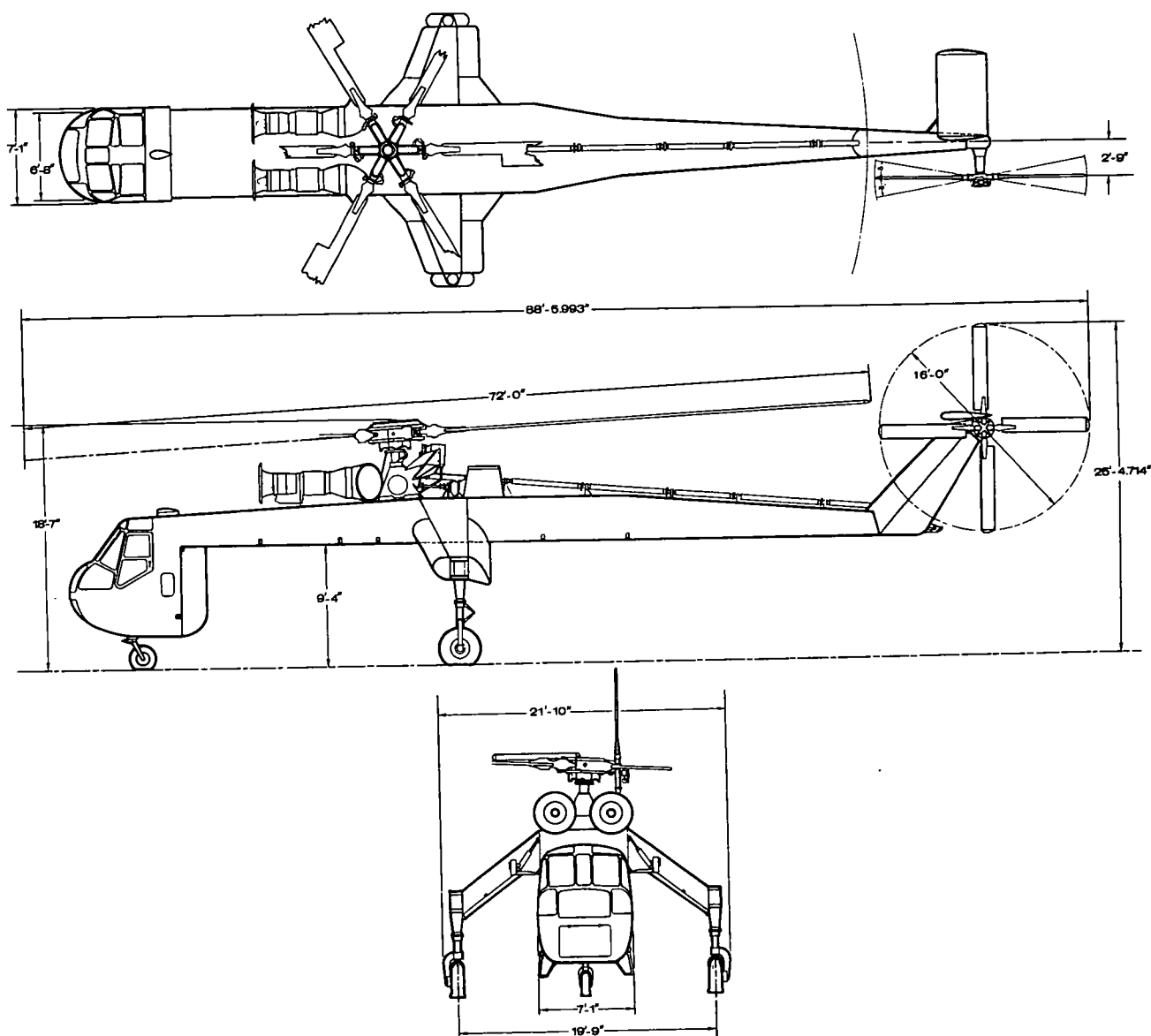


Figure 2-29. CH-54 (Sky Crane).

Section III. OPERATIONS

2-5. Outline Standing Operating Procedure for Air Movements

a. General. Amplification of command policies on use of air transportation (intratheater and intertheater), including responsibilities, utilization, and procedures in the employment of organic aviation units; responsibilities for coordination with Air Force aerial ports.

(1) *Submission of space requirements.* Responsibilities for, timing, format, procedures, and policies affecting submission of advance and firm space requirements for air movement of supplies and personnel.

(2) *Airspace assignments.* Controlling agency; procedures for application, space assignment, and use of space assignments; formats.

(3) *Air priorities system.* Controlling agency; procedures and responsibilities for application, determination, dissemination, and use of priorities; implementation of command policies and directives.

(4) *Aerial port calls.* Responsibilities and procedures for the issue of port calls for supply and personnel movements, implementation and execution of such calls.

(5) *Special movement control actions.* Special actions required to integrate movement control of air transportation with other applicable modes of transportation.

(6) *Loading and unloading of aircraft.* Policies, responsibilities, and procedures for loading and unloading troops, accompanied supplies, and equipment at air terminals.

(7) *Diversions and reconsignments.* Authority, procedures, and channels prescribed for effecting and executing diversions or reconsignments.

b. Supply Movements.

(1) *Designation for air movement.* Authority for, responsibilities, how accomplished and disseminated, actions to be taken.

(2) *Special packing requirements.* Special instructions for packing or preparing supplies for air movement. Responsibility for packing and inspecting before air movement.

(3) *Special marking.* Types, responsibilities for applying marking on containers and for obliterating old markings.

(4) *Documentation.* Responsibilities and procedures for preparing and distributing established documents.

(5) *Airdrops and extractions.* Amplification of command policies and directives on packaging and delivery responsibilities, methods and procedures for obtaining and accomplishing airdrops, methods and responsibilities for marking landing or drop zones.

(6) *Records and reports.* Responsibilities and methods of maintenance of specific records and reference to reports to be submitted.

c. Personnel Movements.

(1) *Preparation for air movement.* Command policies and directives on procedures and requirements for preparing units and individuals for air movement.

(2) *Movement to air terminals.* Procedures and responsibilities for the movement of units and individuals to air terminals for air movement.

(3) *Documentation.* Preparation, distribution, and uses of established flight forms and documentation.

(4) *Records and reports.* Responsibilities and methods for maintenance of specific records and reference to reports to be submitted.

2-6. Outline Standing Operating Procedure for Air Transport Service (Air Force and Army Aviation)

a. General. Policies involved in control, operation, and maintenance of facilities, equipment, and installations; command responsibility; technical supervision required and agencies involved; responsibility for operational control.

b. Mission. Service to be provided by organic aviation units when made available for administrative movements, Air Force troop carrier units, and other aircraft in direct support; extent of operation.

c. Functions.

(1) Scheduled and nonscheduled operations.

(2) Maintenance of equipment: responsibilities, procedures, facilities, inspections.

d. Operational Planning. Personnel, equipment, and supply requirements; capabilities and capacities; communication procedures.

e. Operations. Operational procedures and control; utilization of personnel, equipment, and facilities; priorities; coordination; documentation; records and reports; service to be given personnel and cargo; liaison established between aviation and user units.

f. Maintenance. Responsibilities and procedures for maintenance, regulations, reports, and records.

g. Supply. Responsibilities, authorized levels, procedures, and accounting methods for the Air Force.

h. Intelligence. Responsibility for collection, collation, evaluation, and dissemination of air transportation intelligence.

i. Security. Responsibilities, disaster and defense plans, and equipment and supply security.

j. Records and Reports. Responsibilities: technical, operational, personnel, and stock records and reports.

k. Training. Responsibilities: unit and technical training.

2-7. Weight and Balance Terms

a. Aircraft Balance Limits. The maximum forward and maximum aft permissible locations of the aircraft center of gravity expressed as station numbers or as percentages of the mean aerodynamic chord (MAC). If these limits are exceeded, the aircraft will have unsatisfactory flight characteristics.

b. Center of Gravity (CG). The point about which an object would balance if supported at that point or the point at which the weight of an object or group of objects can be considered concentrated.

c. Reference Datum Line (RDL). An imagi-

nary vertical line at or near the nose of the aircraft from which all horizontal distances are measured. Aircraft diagrams show this line as structural station zero.

d. Station Number. A number, generally marked on the interior of an aircraft, indicating a plane extending across the fuselage of the aircraft parallel to the reference datum line and representing the distance from it in inches.

e. Arm. The horizontal distance in inches from the reference datum line to the center of gravity of an object.

f. Moment. The product of the weight of an item multiplied by its arm. Moment may be expressed in pound-inches; for example, 2 pounds (weight) $\times$ 10 inches (arm) = 20 pound-inches (moment).

g. Allowable Cabin Load—Allowable Cargo Load. The load, of either passengers or cargo, which an aircraft is considered capable of air-lifting safely over a given route under prescribed conditions. Expressed in terms of weight.

h. Basic Weight. The empty weight of an aircraft in its basic configuration, including all appointments, integral equipment, instrumentation, and trapped fuel and oil, but excluding passengers, cargo, crew, and fuel and oil.

i. Operating Weight. Basic weight of the aircraft plus minimum crew but excluding fuel and cargo.

j. Ready-for-Loading Weight. Total aircraft, crew, oil, and fuel weight; or the gross weight less cargo; or the basic weight plus crew, oil, and fuel.

k. Maximum Allowable Gross Weight. The maximum allowed total weight of the aircraft prior to takeoff; the "basic weight" of the aircraft plus the crew, personnel equipment, special devices, passengers/cargo, and usable fuel and oil. This is limited by structure, power available, or landing load.

l. Maximum (Alternate) Gross Weight. A gross weight in excess of the design gross weight. The maximum alternate gross weight

is normally used in combat operations, but does not afford any margin of safety.

2-8. Calculating Safe Placement of Aircraft Loads

a. The general rules for determining the placement of a given load so as to cause the center of gravity of the aircraft to fall within safe limits are as follows:

(1) From the aircraft diagram in the TM 10-series, determine the reference datum line.

(2) Determine the center of gravity of each item involved in the loading. This will be required for computations in (7) below. Calculate the moment for each item.

(3) Select from design data the desirable center of gravity at which the loaded aircraft should balance.

(4) Compute the desired load moment (the ready-for-loading weight of the aircraft and its load multiplied by the distance between the desirable center of gravity and the reference datum line).

(5) Subtract the moment of the ready-for-loading aircraft from the moment of the loaded aircraft.

(6) Obtain the arm (station number) at which to place the load in the aircraft, by dividing the weight of the load into the difference between the gross moment and the ready-for-loading moment.

(7) The arm thus obtained will apply to the point at which the load is concentrated. It must be borne in mind that for multiple-piece loads the moment which applies to the point of load concentration is equal to the sum of the moments for each piece.

Example: The entire load consists of three trucks. Determine center of gravity of each vehicle. Calculate the moment of entire load by accomplishing the following:

Multiply the fuselage station number where

the center of gravity of each vehicle is positioned by the weight of the vehicle. Add these three figures to obtain the total moment in pound-inches.

Weight $\times$ distance = moment (pound-inches)

Vehicle No. 1 = $17,660 \times 627 = 11,072,820$

Vehicle No. 2 = $18,000 \times 992.1 = 17,857,800$

Vehicle No. 3 = $16,000 \times 1157 = 18,512,000$

Total load moment = 47,442,620

Add the weights of the three vehicles to obtain the total load weight.

Vehicle No. 1 = 17,660 pounds

Vehicle No. 2 = 18,000 pounds

Vehicle No. 3 = 16,000 pounds

Total load weight = 51,660 pounds

Divide the total load moment by the total load weight to obtain the fuselage station number at which the center of gravity of the total load is located.

$$\frac{47,442,620}{51,660} = \text{Fuselage station No. 918.4}$$

The total load center of gravity should be as close as possible to the desirable center of gravity of the aircraft. To determine vehicle center of gravity, see paragraph 3-53.

(8) Verify that the load will fit into the aircraft at the desired station.

b. For accurate weight and balance determination, see the -10 manual of the TM 55-series for the appropriate Army aircraft and the -5 and -9 technical orders for the appropriate Air Force aircraft.

2-9. Air Movement Designator

This combination of code letters and numbers is assigned by the issuing agency to identify and indicate precedence of traffic movement within each service's allocation (AR 59-8 and para 7-20). Each air movement designator consists of code symbols in sequence as shown in the following example and as explained below.

	SUU — TAW — 3EL — 5671 — GF — 6	
Origin		Month of shipment
Destination		Shipping agency
Priority		Serial number

Type of Traffic

a. *SUU*—Indicates the MAC airport of origin of the traffic; in this example, "Travis AFB."

b. *TAW*—Indicates the MAC airport of destination of the traffic; in this example, "Tachikawa."

c. *3*—Indicates the priority assigned to the traffic movement; in this example, "Priority 3" (para 2-10).

d. *EL*—Indicates the type of traffic (i.e., whether passenger or cargo moved; in this example, "Passenger—Emergency leave").

e. *5671*—Indicates the traffic movement serial number assigned by the issuing agency; in this example, "Movement No. 5671." (These numbers are issued consecutively, from 0001 through 9999, after which the issuing agency begins again with 0001.)

f. *GF*—Indicates the sponsoring department in whose interest the traffic is being moved; in this example, "The Department of the Army."

g. *6*—Indicates the month in which the traffic is to be moved; in this example, "June."

2-10. Cargo Priorities

<i>MILSTAMP Transportation Priority</i>	<i>MILSTRIP Issue Priority Designator</i>
1	1 through 3
2	4 through 8
3	9 through 15
4	16 through 20

2-11. Restraint

a. *Restraint Safety Factor (RSF)*. A numerical factor developed by the designer of a particular aircraft. The restraint safety factor multiplied by the weight of the cargo gives the total thrust or force that must be compensated for or restrained against in an aircraft.

b. *Cargo Tiedown Fitting Pattern*. The location and spacing of the cargo tiedown fittings in the floor, ceiling, or walls of an aircraft.

c. *Rated Strength*. The safe load capacity of a cargo tiedown device with an applied safety factor.

d. *Effective Angle*. Angle of tiedowns used

to secure cargo to prevent movement in multiple directions.

e. *Restraint Device*. Straps, cable, or chains used to apply the required restraint to cargo and generally referred to as tiedown devices. (Rope may be used only when special devices are not available.)

f. *General Cargo*. Any cargo other than ammunition, vehicles, or personnel.

g. *Tensile Strength*. The greatest longitudinal stress a substance can bear without wearing apart.

2-12. Computing Required Restraint

a. *Restraint Safety Factors*. The restraint safety factor (RSF) is a numerical factor established by the designer of an aircraft. The RSF is sometimes expressed in G's acting on a given load. One G is equal to the force of gravity. This factor multiplied by the weight of the cargo gives the amount of thrust which must be offset with tiedowns. For example, when a C-97 stops abruptly, tiedowns must withstand a forward thrust equal to four times the weight of the cargo. Accordingly, a 1,000-pound load requires 4,000 pounds restraint to withstand forward thrust. Restraint safety factors are determined by certain characteristics of the aircraft—acceleration during take-off, stability during flight, deceleration during landing, and the type of landing field for which it is designed. Aircraft with a greater forward thrust factor require a greater forward RSF. For instance, the C-123 has more of a forward thrust factor than the C-97 because it can stop in a very short distance on relatively unimproved fields.

b. *Rated Strength of Tiedown Devices*. The rated strength (RS) and characteristics of the common type of tiedown devices must be known to determine the kind of device needed. The rated strength includes an applied safety factor. Figure 2-30 illustrates these devices. Appropriate types of tiedown fittings with the highest rated strength should be selected, thereby providing the needed restraint with the least number of fittings.

c. *Types of Tiedown Devices*.

(1) A-1A—An 18-foot length of cotton

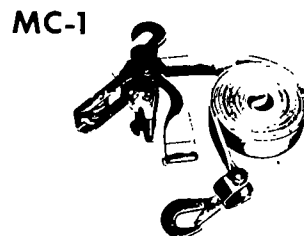
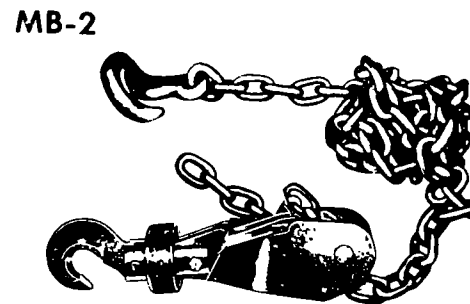
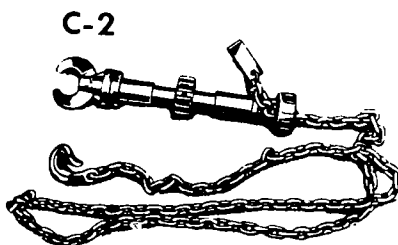
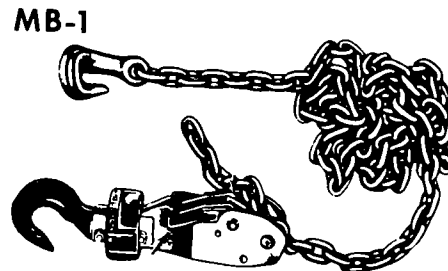
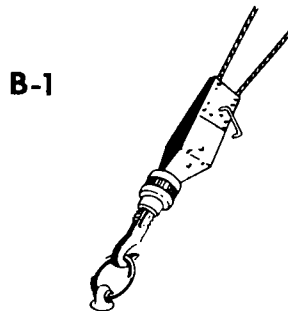
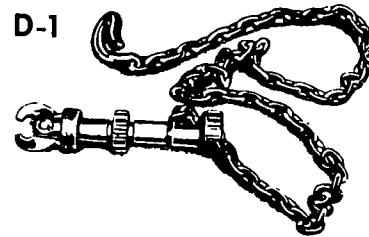
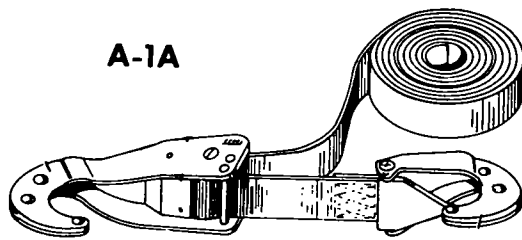


Figure 2-30. Types of tiedown devices.

webbing with two metal hooks, one stationary and one movable, and a quick-release adapter. It has a 1,250-pound rated strength and is used for lashing general cargo. Although still in use, this device is gradually being phased out.

(2) *B-1*—A length of cable with a snap fastener on one end and a quick-release and tightening assembly on the other. It has a 5,000-pound rated strength and is used for general cargo and light vehicles and equipment.

(3) *C-2*—A length of chain with an L-shaped hook at one end and a detachable quick-release jaw and tightening mechanism at the other end. It has a 10,000-pound rated strength and is used for all vehicles.

(4) *D-1*—A steel chain with a hook at one end and a detachable jaw and turnbuckle fitting at the other. It has a 25,000-pound rated strength and is used primarily on heavy vehicles.

(5) *MB-1*—Similar to the *C-2* but with a hook which is engaged with the tiedown fitting in place of the jaws on the *C-2*. It is used with the same chain as the *C-2*. It has a 10,000-pound rated strength.

(6) *MB-2*—Similar to the *D-1*. It has a heavy hook that is engaged with the tiedown fitting and is used with the same hooked chain as the *D-1* except that it has a quick-release device. It has a 25,000-pound rated strength.

(7) *MC-1*—A nylon web strap with two metal hooks, one stationary and one movable. It is similar in appearance to the *A-1A* and has a 5,000-pound rated strength.

(8) *Manila rope*—Usually an 18-foot length of 1/2-inch manila hemp rope with a rated strength of 2,000 pounds.

2-13. Angle of Tie

The effectiveness of a tiedown device is determined not only by its rated strength, but also by the angle at which it is used. This element is the angle of tie. The four basic angles of tie are 45°, 45° x 45°, 30°, and 30° x 30°. Since the 30° angles are most effective against forward thrust, they are used whenever possible. Arrangement of tiedown fittings may make it necessary to use 45° angles. Figure 2-31 illustrates these four angles of tie and summarizes their effectiveness.

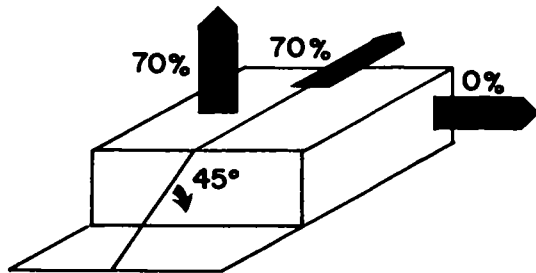
a. Straight 45° Angle. Tiedowns secured at angles of 45° with the cargo floor and in the direction of expected thrust have a holding strength of approximately 70 percent against forward, rearward, and vertical thrusts, but give no protection against sideward thrust. This angle is used for general cargo. When computing straight 45° angles of tie, it is nec-

essary to compute only for forward and sideward thrusts since each tiedown passes over the top of the cargo and attaches to a floor fitting. Since straight 45° ties need not be used in pairs, decimals are rounded off to the next higher number.

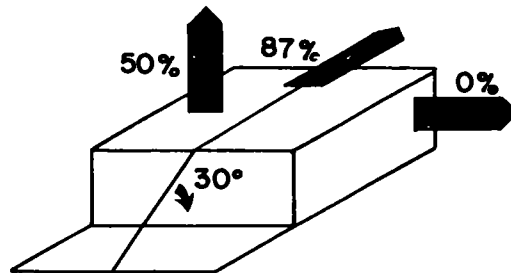
b. 45° x 45° Angle. By using tiedowns secured at a 45° angle with the cargo floor and 45° with the longitudinal axis of the cargo compartment, sideward protection is also obtained. Tiedowns at this angle are used for vehicles. The 45° x 45° combination, however, reduces forward thrust protection to 50 percent but adds 50 percent sideward protection. The restraint against vertical thrusts remains at 70 percent. In this type of arrangement, only the tiedowns for forward and rearward thrusts need be computed, as tiedowns strong enough to protect against forward movement are strong enough for sideward and vertical thrusts. These tiedowns attach on one end to the cargo rather than passing over the top to attach to a floor fitting. In computing the 45° x 45° combination, pairs must always be used, so decimals are rounded off to the next higher even number.

c. Straight 30° Angle. Tiedowns at 30° angles with the cargo floor and in the direction of expected thrust exert a strength of 87 percent against forward and rearward thrusts, 0 percent against sideward thrust, and 50 percent against vertical thrust. Each tiedown at this angle, like the straight 45°, passes over the top and is used for restraining general cargo. To figure straight 30° angles of tie, compute for forward and sideward restraint and round off the decimals to the next higher number.

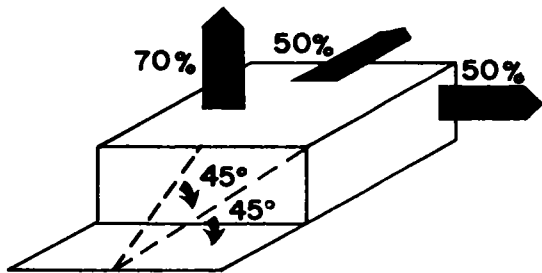
d. 30° x 30° Angle. Tiedowns secured at a 30° angle with the cargo floor and 30° with the longitudinal axis of the cargo compartment hold approximately 75 percent of their rated strength against forward and rearward thrust, 50 percent against vertical thrust, and 43 percent against sideward thrust. This angle of tie is used for vehicles. Tiedowns computed at 30° x 30° angles need only be computed for forward and rearward thrust, as tiedowns strong enough for this protection are strong enough to secure against sideward and vertical thrusts.

**STRAIGHT 45°**

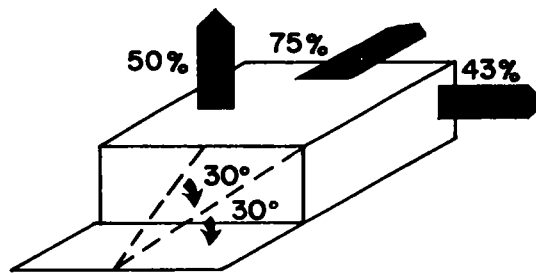
**EFFECTIVE: 70% FORWARD,
REARWARD,
VERTICAL
0% SIDEWARD**

**STRAIGHT 30°**

**EFFECTIVE: 87% FORWARD,
REARWARD
0% SIDEWARD
50% VERTICAL**

**45° X 45°**

**EFFECTIVE: 50% FORWARD,
REARWARD,
SIDEWARD
70% VERTICAL**

**30° X 30°**

**EFFECTIVE: 75% FORWARD,
REARWARD
50% VERTICAL
43% SIDEWARD**

Figure 2-31. Tiedowns at 45° and 30° angles.

These tiedowns attach to the cargo the same as the 45° x 45° angle. Because 30° x 30° combinations are always used in pairs, decimals must be rounded off to the next higher even number.

2-14. Strength and Location of Tiedown Fittings

a. As a chain is only as strong as its weakest link, so is a tiedown device only as strong as the fitting to which it is attached. For example,

a 10,000-pound tiedown device tied to a 40,000-pound fitting has a holding strength of only 5,000 pounds.

b. To determine the number of fittings needed, divide the required number of devices by the number of devices one fitting can sustain.

Example:

$$\frac{48 \text{ devices required}}{2 \text{ devices per fitting}} = 24 \text{ fittings required.}$$

c. For both forward and rearward restraint, devices should be attached in a regular pattern by using corresponding points of attachment on opposite sides of the equipment and corresponding tiedown fittings on each side of the cargo floor centerline.

2-15. Computing Number of Tiedowns Required

a. Two elements used for computing the exact number of tiedowns required in a given situation are—(1) force to be secured, and (2) effectiveness holding strength of one device. The first is the product of the cargo weight and restraint safety factors. The second is the product of the rated strength of the tiedown device and the angle of tie. The first element divided by the second makes up the formula for computing the number of tiedowns required in any situation.

$$\frac{\text{Force to be secured}}{\text{Effective holding strength}} = \text{Number of tiedowns required.}$$

b. Specific working formulas for each angle of tie are as follows:

(1) *Straight 45° angle of tie (forward and sideward)*

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 70\%} = \text{Number of tiedowns}$$

(2) *45° x 45° angle of tie (forward and rearward)*

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 50\%} = \text{Number of tiedowns}$$

(3) *Straight 30° angle of tie (forward and sideward)*

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 87\%} = \text{Number of tiedowns}$$

$$\frac{\text{Cargo weight} \times \text{restraint safety factor}}{\text{Tiedown rated strength} \times 75\%} = \text{Number of tiedowns}$$

Example: C-130 aircraft

¾-ton truck (5,687 pounds) plus
cargo (2,000 pounds)
10,000 pound devices
30° x 30° angle of tie

$$\frac{7,687 \text{ pounds} \times 8 \text{ RSF}}{10,000 \text{ pounds} \times .75} = \frac{61,496}{7,500} = 8.19 \text{ or } 10 \text{ devices for forward restraint}$$

$$\frac{7,687 \text{ pounds} \times 2 \text{ RSF}}{10,000 \text{ pounds} \times .75} = \frac{15,374}{7,500} = 2.05 \text{ or } 4 \text{ devices for rearward restraint}$$

2-16. Typical Loads

See TM 57-210 or TM 1-series (-9 Loading Instruction) for the applicable aircraft for typical loads.

2-17. Standard Parachutes and Carrying Capacities

Parachute	Diameter (ft)	Maximum load capability (lb)
G-12D	64	2,200
G-13	24.25	500
G-11A	100	3,500
T-7A	28	300

2-18. Aerial Delivery Containers and Typical Loads

Container	Average safe load (lb)	Typical load
A-7A	500	Packaged nonfragile supplies
A-21	500	Fragile and nonfragile supplies
A-22	2,200	Fragile and nonfragile supplies
A-22 (G-12D)	750	Fragile and nonfragile supplies

2-19. Loading or Unloading Time for Army Aircraft

a. *Rotary-Wing Aircraft.*

- (1) Troops—3 minutes.
- (2) Casualties—10 minutes.
- (3) Cargo, in fuselage—5 to 25 minutes, depending on the type cargo and aircraft.
- (4) Cargo, external load—30 seconds.
- (5) Refueling—
 - (a) Observation (OH-13 and OH-23)—7 minutes.
 - (b) Utility (UH-19 and UH-1)—10 minutes.
 - (c) Light transport (CH-21 and CH-34)—15 minutes.
 - (d) Medium transport (CH-37 and CH-47)—20 minutes.

b. *Fixed-Wing Aircraft.*

- (1) Troops—approximately 2 to 3 minutes, depending on aircraft.

- (2) Casualties—10 minutes.
- (3) Cargo, in fuselage—
 - (a) Load—10 to 30 minutes, depending on cargo.
 - (b) Unload—5 to 15 minutes.
- (4) Cargo, external load—
 - (a) Load—10 minutes.
 - (b) Air-landed—10 minutes.
 - (c) Parachute—30 seconds.
 - (d) Free fall.
- (5) Refueling—
 - (a) Observation, light (0-1)—5 minutes.
 - (b) Utility (U-6)—8 minutes.
 - (c) Transport (U-1A)—15 minutes.
 - (d) Staff transport (U-8)—10 minutes.

2-20. Maximum Ground Times for Air Force Aircraft

The following information may be used for general planning purposes:

a. Cargo Flights. Ground time at point of origin is 3 hours; 2 hours is time at en route bases. At destination bases where only off-loading is done, 2.5 hours is ground time.

b. Passenger Flights. Aircraft have maximum ground times of 2.5 hours at on-load bases and 3 hours at destination bases for off-loading and reloading.

2-21. Aircraft Landing Sites

See FM 57-35, FM 1-100, TM 5-330 and TM 5-366.

2-22. Estimating Army Aircraft Movement Capability

a. General. To assess capability to move personnel and supplies by Army aircraft, the analyst must consider the various factors involved. Some or all of the factors will apply to a particular problem. Factors involved and methods of making capability estimates are given in *b* and *c* below.

b. Factors Involved. Depending upon the nature of a particular mission, the analyst must consider the following:

- (1) *Type and number of aircraft involved.*
- (2) *Loading.*
 - (a) Weight of cargo and lift capability (payload) of aircraft.

(b) Configuration of cargo in relation to size of cargo compartment and cargo compartment doors.

(c) Sling loads for helicopters.

(d) Wing loads for fixed-wing aircraft.

(3) *Hours of daily operation (flying hours).*

(a) Helicopters—4.

(b) Fixed-wing aircraft—6.

(4) *Daily round trips per aircraft.* This is obtained by dividing daily flying hours by the product of the round-trip distance divided by flying speed plus pattern time.

(5) *Availability.* Availability is affected by the adequacy and efficiency of maintenance and supply and by the relative location of operating and service units. The average availability of aircraft on hand for sustained and short-term operations is shown below.

	Sustained (percent)	Short-term (percent)
Fixed-wing aircraft	75	90
Helicopters	67	90

(6) *Aircraft requirement.* The number of aircraft sorties required to accomplish a mission is determined by two factors—the basic requirement and the type of operation.

(a) *Basic requirement.* The number of aircraft needed to meet the basic requirement is obtained by dividing the total tonnage to be moved by the payload of one aircraft of the type to be used in the operation.

(b) *Type of operation.* The basic aircraft requirement figure has to be adjusted according to the variable factors involved. The most common variable factors are—

1. *Distance.* Distance causes the fuel and payload relationship to vary inversely. When the operation exceeds 50 miles (80 kilometers), the basic aircraft requirement should be increased approximately 7 percent for each 20-mile (32-kilometer) increment.

2. *Sustained operation.* In a sustained operation, the basic number of aircraft required should be increased by 50 percent.

3. *Combat loading.* A 10-percent increase of the basic requirement is necessary for combat loading.

4. *Miscellaneous variables.* As altitude and/or temperature increase, the aircraft

requirements will also increase because of a decrease in weight lifting capability. Humidity and other weather conditions also affect the aircraft requirement. The analyst must determine the adjustments to be made because of these variables.

c. Making the Estimate. When estimating the aircraft requirement or the tons that can be moved daily by aircraft, use the formula below.

(1) *Formula.*

$$A = B \times C \times D$$

Where

- A = daily tonnage capability
- B = daily round trips flown per aircraft
- C = payload of one aircraft
- D = number of aircraft employed

(2) *Movement by helicopter.*

(a) *Problem.* What is the daily lift capacity of 25 helicopters in the communications zone where

- 4 = operational hours
- 90 = average speed in miles in the hour (includes loading and unloading time)
= 144.8 kilometers in the hour
- 75 = round trip distance in miles
= 120.7 kilometers
- 90 = percent of aircraft available
- 1.4 = short tons of payload of reach aircraft
- 0.9 = availability of 90 percent

(b) *Solution.*

$$B = \frac{4 \times 90 \text{ mih}}{75 \text{ miles}} \text{ or } \frac{4 \times 144.8 \text{ kmih}}{120.7 \text{ kilometers}} = 5 \text{ round trips per aircraft}$$

$$A = 5 \times 1.4 \times 25 \times 0.9 = 157 \text{ short tons per day}$$

(3) *Movement by fixed-wing aircraft.*

(a) *Problem.* What is the sustained fixed-wing aircraft requirement to move 500 short tons of cargo per day a distance of 35 miles (56.3 kilometers) under combat conditions where

- 1.1 = multiplier for combat loading
- 1.5 = multiplier for sustained operations

- 1.4 = short tons of payload for each aircraft
- 80 = average speed in miles in the hour (includes loading and unloading time)
= 128.7 kilometers in the hour
- 6 = operational hours per day

2-23. Strategic Airlift

This paragraph contains a monograph (fig. 2-32) which provides staff planners a rapid and accurate method for determining strategic airlift capability, requirements, and deployment times under sustained operations.

a. General. Although aircraft planning factors and related data are available in various Army and Air Force manuals, these factors are neither correlated nor assembled in such manner as to permit their ready application to strategic air transport problems that daily confront staff planners. This graph is designed to overcome this deficiency and, in addition, eliminates the many tedious computations required for determining airlift capability and deployment times as shown in the example of standard methodology below. To make full use of this graph, particular note should be made of the "Uses and Application" at the end of this section and the "Explanatory Notes" on the graph.

b. Standard Methodology. Determine the time required to deploy a unit with 3,330 personnel and 625 short tons (STON) of equipment/supplies from Okinawa to Saigon (distance of 1,816 nautical miles) with 50 C-124 aircraft.

(1) *Compute monthly ton-mile outbound capability.*

Step 1. Distance $\div$ speed = flying time (FT) $\times$ ton-mile (TM)/hour capability $\times$ No. of aircraft = one-way lift capability

$$\text{Example: } 1,816 \div 190 = 9.6 \times 2,242 \times 50 = 1,076,160 \text{ TM one-way left capability}$$

Step 2. Monthly utilization rate (FT/day $\times$ 30) $\div$ round trip FT (FT $\times$ 2) = sorties/month $\times$ one-way lift capability = monthly outbound capability in ton-miles.

Example: $(8 \times 30) 240 \div (9.6 \times 2) 19.2 = 12.5 \times 1,076,160 = 13,452,000$ ton-miles monthly outbound capability

(2) *Determine deployment time.*

Step 1. Compute ton-mile requirement. Personnel $\div$ conversion factor = short tons + STON equipment/supplies $\times$ distance = ton-mile requirement

Example: $3,330 \div 7 = 476 + 625 = 1,101 \times 1,816 = 1,999,416$ ton-mile requirement

Step 2. Ton-mile requirement $\div$ monthly outbound capability = percent month $\times$ base month = deployment time in days

Example: $1,999,416 \div 13,452,000 = .149 \times 30 =$ approximately $4\frac{1}{2}$ days deployment time. (See first example on graph)

c. *Functions and Factors Employed for Graph.*

(1) *Aircraft payload.* The payload (ACL—allowable cabin load) of a transport aircraft, in short tons, is obtained from the payload-range curve for the aircraft. Since the payload reduces as the nonstop range increases, the longest nonstop distance (critical leg) of the route determines the maximum cargo payload for an entire route because effective strategic airlift operations assume the movement of a fixed load over all legs of a route. Since unit movement requirements include primarily outsize/vehicle (bulky or low density) cargo, average ACL's are provided for both bulk and outsize cargo.

(2) *Aircraft speed.* Speed in knots (nautical miles per hour) is used herein.

(3) *Aircraft utilization rate.* The above elements reflect basic characteristics of the aircraft and are relatively firm, whereas utilization rate, the planned flying hours per day/month, is variable and affects airlift capability accordingly. For this graph, it was considered that airlift operations are conducted on a sustained basis based on a smooth flow of airlift resources and do not exceed the utilization rate shown below.

(4) *Airlift capability.* Airlift capability is the product of the above elements, payload times speed times utilization, and is expressed in ton-miles per hour or month as the case may be.

(5) *Ton-mile requirement.* Short tons of passengers, equipment, and supplies to be moved times the distance to be moved.

d. *Value of Functions and Factors Employed for Graph.*

(1) *Aircraft payload.* (Average outsize/vehicle capability used).

Type	Outside cargo (Avg ACL)	Bulk cargo (Avg ACL)
C-124 -----	11.8 short tons ..	15.0 short tons
C-130 -----	9.8 -----	14.3

(2) *Speed.* (Nautical miles per hour)

C-124 -----	190
C-130 -----	270

(3) *Utilization rate.* (Flying hours per day)

C-124 -----	8
C-130 -----	8

(4) *Ton-mile hour capability.* (Outsize cargo payload times speed)

C-124 -----	2,242
C-130 -----	2,646

(5) *Ton-mile requirement.* (For both C-124 and C-130 aircraft)

(a) *Passenger conversion factor.* 7 troops = 1 short ton (combined passenger and baggage weight of approximately 286 pounds). Use precomputed personnel short ton conversion chart (fig. 2-33).

(b) *Equipment/supplies.* Actual weight in short tons.

(c) *Distances.* Use table of approximate airline distances (fig. 2-34).

e. *Uses and Application.* The three main uses and examples of applicable factors are shown in f through h below.

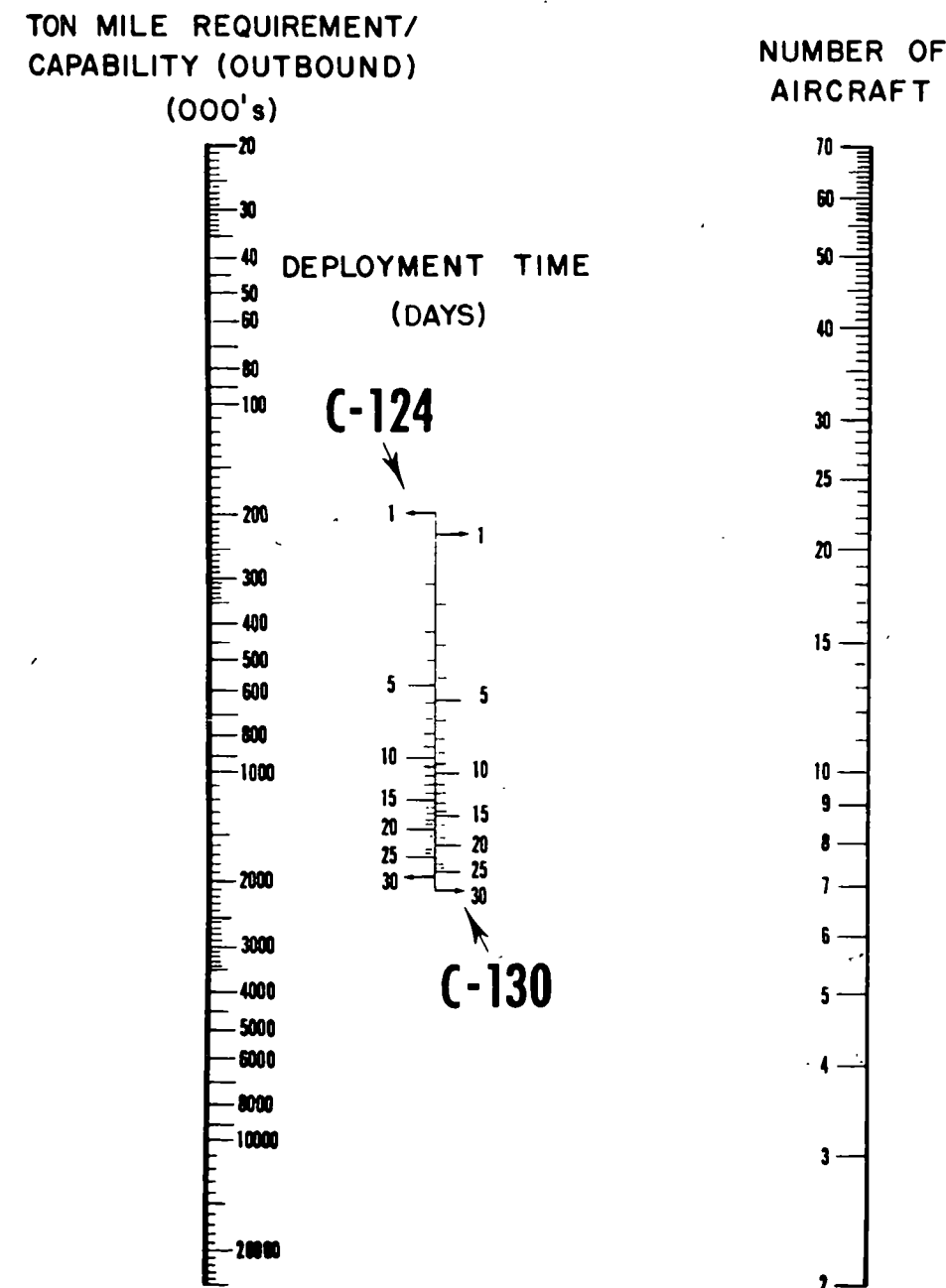
f. *Use for Other Types of Aircraft.*

(1) *Conversion factors.* (C-124 and C-130 AIRCRAFT EQUIVALENTS (This graph can also be used if the airlift force contains other types of aircraft. By application of conversion factors, a given inventory of various types of military transport aircraft can be converted to either C-124 or C-130 "equivalents" and applied to the number of aircraft scale on the graph. These factors are as follows:

STRATEGIC AIRLIFT - PACOM AREA

CAPABILITY - REQUIREMENTS - DEPLOYMENT TIMES

C-124/C-130 AIRCRAFT



USES OF GRAPH	
To determine:	
① DEPLOYMENT TIME (DAYS):	If the requirement and number of aircraft are known.
② TON MILE CAPABILITY (OUTBOUND):	If the number of aircraft and deployment time are known.
③ NUMBER OF AIRCRAFT REQUIRED:	If the requirement and deployment time are known.
EXAMPLES AND APPLICATION	
① DEPLOYMENT TIME (DAYS): Determine the time required to deploy a unit with 3330 personnel and 625 short tons (S/T) of equipment/supplies from Okinawa to Saigon (distance of 1816 nautical miles-from chart page II-1-1) with 50 C-124 or 50 C-130 aircraft. Step 1 - Compute ton mile requirement (S/T x Distance). Convert personnel to S/T (use chart page II-6-7) 3330 pers = 476 S/T + 625 S/T equip/supplies = 1101 total S/T requirement x 1816 miles (use chart page II-6-8) = 1,999,400 ton mile requirement, rounded off to 2,000,000. Place a mark at 2000 on the Ton Mile Requirement scale. Step 2 - Place a mark at 50 on the Number of Aircraft scale. Step 3 - Draw a straight line connecting the marks on both scales and the intersecting point on the Deployment Time (Days) scale of approximately $4\frac{1}{2}$ for C-124 and $3\frac{3}{4}$ for C-130 is the number of days required to deploy this unit with C-124 or C-130 aircraft.	
② TON MILE CAPABILITY (OUTBOUND): Determine the total ton mile capability of 25 C-124 aircraft for a nine (9) day period. Step 1 - Place a mark at 25 on the Number of Aircraft scale. Step 2 - Place a mark at 9 on the C-124 Deployment Time (Days) scale. Step 3 - Draw a straight line from 25 on the Number of Aircraft scale through 9 on the C-124 Deployment Time scale and extend the line to the Ton Mile Capability scale. The reading of approximately 2,000,000 will be the total outbound ton mile capability of 25 C-124 aircraft for a nine (9) day period.	
③ NUMBER OF AIRCRAFT: Determine the number of C-130 aircraft required to deploy in four (4) days a ton mile requirement of 2,000,000. Step 1 - Place a mark at 2000 on the Ton Mile Requirement scale. Step 2 - Place a mark at 4 on the C-130 Deployment Time (Days) scale. Step 3 - Draw a straight line from 2000 on the Ton Mile Requirement scale through 4 on the C-130 Deployment Time scale and extend the line to the Number of Aircraft scale. The reading of approximately 46 will be the number of C-130 aircraft required to deploy in 4 days a 2,000,000 ton mile requirement.	
EXPLANATORY NOTES	
1/ AIRCRAFT ASSEMBLY TIME: (See text on page II-6-3). This graph is valid only from the date the operation begins and the user must consider use of one of the following options: a. Assume that sufficient warning time was given for aircraft assembly time prior to the date the operation begins, or b. Estimate the number of days required for aircraft assembly time and add this number of days to the deployment time derived from the graph.	
2/ SCALE VALUES: Although this graph reflects specific scale values, it is applicable to higher or lower scale values by merely applying the percentage change to the answer derived from any of the given uses. Examples: a. The time required to deploy a unit with double the requirement shown in the first example under application would be approximately 9 days for C-124 and $7\frac{1}{2}$ days for C-130 aircraft. This is obtained by applying the 100% increase in ton mile requirement (4,000,000 ÷ 2,000,000) to the answer of $4\frac{1}{2}$ and $3\frac{3}{4}$ days for C-124 and C-130 aircraft, respectively. b. A utilization rate of 8 hours/day (240 hours/month) was used. If a higher or lower rate is planned, the percentage change is applicable as indicated in a. above.	

Figure 2-32. Strategic airlift nomograph.

3000021246

PRECOMPUTED PASSENGER: SHORT TON CONVERSION CHART

<u>Number of Passengers</u>	<u>Number of Short Tons</u>	<u>Number of Passengers</u>	<u>Number of Short Tons</u>	<u>Number of Passengers</u>	<u>Number of Short Tons</u>
7	1	252	36	497	71
14	2	259	37	504	72
21	3	266	38	511	73
28	4	273	39	518	74
35	5	280	40	525	75
42	6	287	41	532	76
49	7	294	42	539	77
56	8	301	43	546	78
63	9	308	44	553	79
70	10	315	45	560	80
77	11	322	46	567	81
84	12	329	47	574	82
91	13	336	48	581	83
98	14	343	49	588	84
105	15	350	50	595	85
112	16	357	51	602	86
119	17	364	52	609	87
126	18	371	53	616	88
133	19	378	54	623	89
140	20	385	55	630	90
147	21	392	56	637	91
154	22	399	57	644	92
161	23	406	58	651	93
168	24	413	59	658	94
175	25	420	60	665	95
182	26	427	61	672	96
189	27	434	62	679	97
196	28	441	63	686	98
203	29	448	64	693	99
210	30	455	65	700	100
217	31	462	66	798	114
224	32	469	67	903	129
231	33	476	68	1001	143
238	34	483	69	2002	286
245	35	490	70	3003	429

- NOTES:
1. Passengers and short tons are shown in multiples of 7 and 1. For ease in computation, fractions of these multiples should be rounded off to the next highest multiple of 7 passengers or 1 short ton.
 2. Use combinations of the above conversions for number of passengers not shown.

Figure 2-33. Precomputed personnel short ton conversion chart.

TABLE OF APPROXIMATE AIRLINE DISTANCES—PACIFIC AREA NAUTICAL MILES

ROUTE REF NO.	AREA/AIRFIELD	U. S. - TRAVIS	- McCHORD	- RANGOON BURMA	- HONG KONG CHINA	- SHANGHAI	- GUAM ANDERSON	- HAWAII HICKAM	JOHNSTON ISLAND	- JAPAN TACHIKAWA	KWAJALEIN ISLAND	- KOREA KIMPO	MIDWAY ISLAND	- OKINAWA KADENA	PHILIPPINE I. - CLARK	- SAIGON S. VIETNAM	- TAIPEI TAIWAN	- BANGKOK THAILAND	WAKE ISLAND
(1)	U. S. - TRAVIS	0	578	8461 (14)	7469 (14)	6536 (9)	5461 (18)	2142	2852 (7)	5551 (12)	4273 (8)	6296 (9)	3289 (7)	6350 (18)	6891 (18)	7814 (14)	6716 (13)	8144 (14)	4151 (7)
(2)	- McCHORD		0	8647 (14)	7655 (14)	6722 (9)	5647 (18)	2328	3038 (7)	5737 (12)	4459 (8)	6482 (9)	3475 (7)	6536 (18)	7077 (18)	8000 (14)	6902 (13)	8330 (14)	4337 (7)
(3)	BURMA - RANGOON			0	2228 (15)	2887 (4)	3000 (14)	6319 (18)	5803 (10)	3310 (14)	4382 (6)	3138 (13)	5341 (18)	2463 (14)	1570 (17)	725 (17)	2200 (14)	317	4310 (6)
(4)	CHINA - HONG KONG				0	659	2008 (14)	5327 (18)	4811 (10)	1718 (16)	3390 (6)	1515 (13)	4349 (18)	840 (16)	578	1503	474	1911 (15)	3318 (6)
(5)	- SHANGHAI					0	1690 (13)	4394 (12)	4127 (18)	985	3386 (18)	466	3247 (9)	440	1001 (13)	2162 (4)	371	2570 (15)	2750 (9)
(6)	GUAM - ANDERSON						0	3319 (18)	2687 (18)	1386	1382	2131 (9)	2341 (18)	1250	1430	2353 (14)	1616 (13)	2683 (14)	1310
(7)	HAWAII - HICKAM							0	710	3409 (12)	2131 (8)	4154 (9)	1147	4280 (9)	4749 (6)	5672 (14)	4646 (13)	6002 (14)	2009
(8)	JOHNSTON ISLAND								0	3142 (18)	1421	3887 (18)	816	3576 (18)	4233 (6)	5156 (14)	4303 (13)	5486 (14)	1377
(9)	JAPAN - TACHIKAWA									0	2401 (18)	745	2262	871	1740	2663 (14)	1244	2993 (14)	1765
(10)	KWAJALEIN ISLAND										0	3146 (9)	1667 (18)	2632 (6)	2812 (6)	3735 (14)	2998 (13)	4065 (14)	636
(11)	KOREA - KIMPO											0	3007 (9)	675	1568 (13)	2491 (14)	1041 (13)	2821 (14)	2510 (9)
(12)	MIDWAY ISLAND												0	3133 (9)	3771 (6)	4694 (14)	3506 (9)	5024 (14)	1031
(13)	OKINAWA - KADENA													0	893	1816 (14)	366	2146 (14)	2129
(14)	PHILIPPINE I. - CLARK														0	923	630	1253	2740 (6)
(15)	S. VIETNAM - SAIGON															0	1553 (14)	408	3663 (6)
(16)	TAIWAN - TAIPEI																0	1883 (14)	3370 (6)
(17)	THAILAND - BANGKOK																	0	3993 (6)
(18)	WAKE ISLAND																		0

*Number in paren () after distances indicates airline routing.

DISTANCE / TIME

DISTANCE (NAUTICAL MILES)	AIRCRAFT/SPEED IN KNOTS		DISTANCE (NAUTICAL MILES)	AIRCRAFT/SPEED IN KNOTS		DISTANCE (NAUTICAL MILES)	AIRCRAFT/SPEED IN KNOTS		DISTANCE (NAUTICAL MILES)	AIRCRAFT/SPEED IN KNOTS		DISTANCE (NAUTICAL MILES)	AIRCRAFT/SPEED IN KNOTS		DISTANCE (NAUTICAL MILES)	AIRCRAFT/SPEED IN KNOTS		DISTANCE (NAUTICAL MILES)	AIRCRAFT/SPEED IN KNOTS	
	C-124/200 HR MIN	C-130/270 HR MIN		C-124/200 HR MIN	C-130/270 HR MIN		C-124/200 HR MIN	C-130/270 HR MIN		C-124/200 HR MIN	C-130/270 HR MIN		C-124/200 HR MIN	C-130/270 HR MIN		C-124/200 HR MIN	C-130/270 HR MIN		C-124/200 HR MIN	C-130/270 HR MIN
200	1 00	0 45	1300	6 30	4 49	2400	12 00	8 54	4600	23 00	17 03	6800	34 00	25 11	7000	35 00	25 56	7200	36 00	26 40
300	1 30	1 07	1400	7 00	5 11	2600	13 00	9 38	4800	24 00	17 47	7400	37 00	27 25	7600	38 00	28 09	7800	39 00	28 54
400	2 00	1 29	1500	7 30	5 34	2800	14 00	10 23	5000	25 00	18 32	7600	38 00	28 09	7800	39 00	28 54	8000	40 00	29 38
500	2 30	1 51	1600	8 00	5 56	3000	15 00	11 07	5200	26 00	19 16	7800	39 00	28 54	8000	40 00	29 38	8200	41 00	30 23
600	3 00	2 14	1700	8 30	6 18	3200	16 00	11 51	5400	27 00	20 00	8000	40 00	29 38	8200	41 00	30 23	8400	42 00	31 07
700	3 30	2 36	1800	9 00	6 40	3400	17 00	12 36	5600	28 00	20 45	8200	41 00	30 23	8400	42 00	31 07	8600	43 00	31 51
800	4 00	2 58	1900	9 30	7 03	3600	18 00	13 20	5800	29 00	21 29	8400	42 00	31 07	8600	43 00	31 51	8800	44 00	32 36
900	4 30	3 20	2000	10 00	7 25	3800	19 00	14 05	6000	30 00	22 14	8600	43 00	31 51	8800	44 00	32 36			
1000	5 00	3 43	2100	10 30	7 47	4000	20 00	14 49	6200	31 00	22 58									
1100	5 30	4 05	2200	11 00	8 09	4200	21 00	15 34	6400	32 00	23 43									
1200	6 00	4 27	2300	11 30	8 31	4400	22 00	16 18	6600	33 00	24 27									

Figure 2-34. Table of approximate airline distances.

Type of aircraft	Conversion factors	
	C-124 equivalent	C-130 equivalent
C-124 -----	1.	—
C-130 -----	—	1.
C-133 -----	3.25	2.76
C-141 -----	2.93	2.48
C-97 -----	.72	.61
C-135 (Bulk cargo only) ..	(1.01)	(.86)
C-121 (Bulk cargo only) ..	(2.71)	(2.30)

(2) *Application of conversion factors.*

The number of C-124 or C-130 aircraft equivalents is derived by multiplying the number of given types of aircraft by applicable C124 or C-130 factors shown above. For example, conversion of an inventory to C-124 equivalents is as follows:

Aircraft in inventory Type	Number	× Conversion factor	= C-124 equivalent
C-124 -----	20	1.	20
C-97 -----	10	.72	7
C-133 -----	4	3.25	13
C-141 -----	10	2.93	29
Totals ..	44	---	69

g. Use if Requirement is Bulk Cargo.

(1) *Conversion factors.* Aircraft payloads used in this graph were based on the outsize/vehicle average ACL of the C-124 and C-130 aircraft. This graph can be used if the movement requirement consists of only bulk cargo by applying the following conversion factors to the answer derived from any of the given uses:

Use (answer)	Conversion factors	
	C-124 scale	C-130 scale
Deployment time -----	.79	.69
Ton-mile capability -----	1.27	1.45
No. of aircraft -----	.79	.69

(2) *Application of conversion factors.*

The answer derived from use of the graph "as is" is merely multiplied by the conversion factors shown above to derive a new answer. This will reflect the increased capability if only bulk

cargo is to be moved. An example of the application of C-124 conversion factors is shown below.

Example	Outside cargo answer	× Conversion factor	= Bulk cargo answer
Deployment time	4.5 days	.79	3.6 days
Ton-mile capability	2,000,000	1.27	2,540,000
No. of aircraft	46	.69	32

h. Use if Scale Values for Other Types of Aircraft Are Desired.

(1) *Conversion factors.* By application of conversion factors to the answer derived from any of the given uses, this graph can also be used if answers are desired for other type aircraft scale values. These factors are as follows:

Use (answer)	Graph acft scale value	Conversion factors				
		C-133	C-141	C-97	C-121*	C-135*
Deployment time and No. of aircraft	C-124	.31	.34	1.39	.99	.37
	C-130	.36	.41	1.64	1.17	.44
Ton-mile capability	C-124	3.24	2.93	.72	1.01	2.71
	C-130	2.76	2.48	.61	.86	2.30

*Bulk cargo only.

(2) *Application of conversion factors.*

The answer derived from use of the graph "as is" is merely multiplied by the conversion factors shown above to derive a new answer. This will reflect the scale values of the type aircraft desired. For example, the C-141 conversion factors above, as applied to each example shown on the graph, is as follows:

Example	C-124/-130 answer	× C-141 conversion factor	= C-141 answer
Deployment time	4.5 days	.34	1.53 days
Ton-mile capability	2,000,000	2.93	5,860,000
No. of aircraft	46	.41	19

